Grand Staircase-Escalante NM

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# Landscape Assessment for the Buckskin Mountain Area

## Wildlife Habitat Improvement

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# CHAPTER 1

*INTRODUCTION*

## A. Background and Need for Management Activity

The Grand Staircase-Escalante National Monument (GSENM) recognizes that pinyon-juniper woodlands and sagebrush desertscrub are key areas for habitat enhancement or improvement, and identifies four primary needs for such activities. First, these habitats provide important habitat for a variety of wildlife species. They contain transition areas for migrating mule deer, winter range for mule deer and Merriam's turkeys, breeding habitat for many migratory bird species, and year-round habitat for several species of birds, reptiles, and small mammals. Second, the quality of the habitat in the Buckskin Mountain area has been impacted by decades of fuelwood gathering. Woodland and sagebrush habitats have been invaded by exotic plants (i.e., cheatgrass, and scotch thistle) and have experienced little shrub regeneration. Given the appearance of browse species, cattle or mule deer use of shrubs, such as cliffrose and big sagebrush, may be exceeding annual growth. Consequently, these species are unlikely to provide adequate forage for future generations of deer. Third, decadent conditions exist in interior woodland stands that have not been affected by fuelwood gathering, and shrub-steppe habitat that has been affected by ungulate grazing and drought. These decadent conditions provide poor quality habitat for most wildlife species. Decadent woodland stands typically have dense overstories of primarily juniper trees, with little understory growth to provide food and cover. Decadent shrub-steppe stands typically have dense overstories of primarily mature to decadent sagebrush with little to no understory growth. Finally, pinyon-juniper woodlands may be encroaching on sagebrush and grassland areas that are vital as habitat for sage grouse, pronghorn antelope and sagebrush and grassland birds. The Monument also recognizes the value of woodlands for wood products for human use, such as firewood, poles, posts, pine nuts, etc.

## B. Purpose

The purpose of this assessment is to document habitat conditions in pinyon-juniper woodlands and sagebrush shrub-steppe of the Buckskin Mountain portion of the Grand Staircase-Escalante National Monument; to synthesize historic and current information about such conditions; to recognize wildlife habitat needs; and to identify strategies for improving habitat conditions. This is the first step toward a long-term goal of habitat improvement and vegetation restoration for the Buckskin Mountain portion of the Monument. This document is intended to aid the Monument in determining the need for and developing management activities within Buckskin Mountains. This document will be revised as new information becomes available.

## C. Description of the Assessment Area

The approximately 41,260 acre (16,700 ha) assessment area is located in the southern portion of the Grand Staircase-Escalante National Monument, Kane County, Utah (Map 1). This is the northern-most extent of the Kaibab Plateau in an area called the Buckskin Mountains. Within the assessment area is approximately 19,440 acres (7865 ha) within the Buckskin Mountain Fuelwood area (Map 2). This ecosystem is classified as Great Basin Conifer Woodlands and Great Basin Desertscrub, [1] and occurs at elevations from approximately 4840 to 6450 feet. This area provides the Paunsagunt and Kaibab deer herds with primary and critical winter ranges, and transitional areas used during migration.

[1] Page 52 in Brown, D.E. 1994

Humans do not inhabit pinyon-juniper woodlands within the Buckskin Mountains; however, the woodlands are used recreationally for hunting, hiking, camping, and wildlife viewing. The area is also used for livestock grazing with portions of five Allotments within the Buckskin Assessment area: Coyote-AZ, Mollies Nipple, Rock Reservoir, Sink Holes and Vermilion (Tables 1-2, Map 3). Cattle grazing occurs within the Assessment on a seasonal basis. Residents of the nearby communities of Fredonia (AZ), Kanab (UT) and Page (AZ) utilize portions the woodlands for fuelwood harvesting. Additionally, members of the Paiute, Navajo and Hopi tribes may utilize them for pinyon nut harvesting and ceremonial purposes. There are currently no active mines within the woodlands of the Buckskin Mountains.

A detailed description of the physical and environmental condition of the area and details of human land use practices are provided in the following chapters. No specific sites within the area are suggested for habitat improvement projects.

# CHAPTER 2

*CURRENT LANDSCAPE CONDITION*

This chapter describes the existing landscape conditions within the Buckskin Mountain Assessment area. It details both the physical and biological environments, as well as the human values that are currently at work in shaping the landscape.

## A. Physical Environment

### Geology

The Buckskin Mountain Assessment area is located within the southwestern section of the Colorado Plateau, within the geologic province referred to as the Kaibab Plateau. The Kaibab Plateau is an asymmetric north-south trending anticline, bounded on the east by the East Kaibab Monocline and on the west by the Big Springs Fault Zone. This anticline is a product of compressional forces that occurred about 50 million years ago during the Laramide Orogeny.

The study area is situated on the northwestern limb of the Kaibab Anticline and consists predominately of Triassic age carbonates, sandstones and siltstones of the lower Moenkopi Formation. This unit is known as the Timpoweap Member. It forms a resistant cap over the older Permian rocks, which crop out in gullies and small canyons cut within the upwarp. The oldest exposed rocks in the study area are found at the northeast boundary within Buckskin Gulch. Here Permian age rocks of the Kaibab, Toroweap, Coconino, and Hermit formations are exposed.

### Climate

The Buckskin Mountain Assessment area is influenced by a cold-temperate climate. Precipitation is sparse. Average annual precipitation for Kanab (20 miles to the west; 1948-1992) is 33.8 cm (13.31 inches) per year[2]. Buckskin Climate station[3] (March 2002 – February 2003) recorded annual precipitation of 15.9 cm (6.27 inches) for the year[4]. Precipitation occurs bimodally, in two distinct periods of winter snowfall and summer monsoon rains[5]. Summer rainstorms are typically intense and spottily distributed across the landscape. The majority of precipitation within the Buckskin Mountain area appears to be received during fall, at least from one year's data[6]. Buckskin Climate station data showed that most of the annual precipitation was in the fall (5.7cm [2.26 inches]), followed by winter (4.5 cm [1.78 inches]), and Summer (4.2 cm [1.67 inches]), with the least amount of precipitation in the Spring (1.4cm [0.56 inches]).

In general, Southwest pinyon-juniper woodlands are arid lands characterized by cold winters, with freezing possible 150 or more days per year; and hot summers during which maximum temperatures can exceed 38 ˚Celsius (100.4 ˚Fahrenheit)[7]. Temperatures in the Kanab area average 12.4 ˚C (54.4 ˚F)[8]. Temperatures for

[2] Buckskin Mountain Assessment project record document No. 71.
[3] UTM 12 406917E 4103934N (NAD27), available at http://www.met.utah.edu/cgi-bin/roman/meso_base.cgi?stn=GSE10&unit=0&time=LOCAL
[4] Buckskin Mountain Assessment project record document No. 72.
[5] Buckskin Mountain Assessment project record document No. 71.
[6] Buckskin Mountain Assessment project record document No. 72.
[7] Page 52 in Brown, D.E. 1994. Biotic communities: southwestern United States and Northwestern Mexico. University of Utah Press. Salt Lake City, Utah

one year at the Buckskin Climate station averaged 22.5 ˚C (72.5 ˚F) max and 5.2 ˚ C (41.3 ˚ F) min. Minimum and maximum for the year were –16.8 ˚C (1.8 ˚F) and 39.9˚C (103.8˚ F)[9].

**Air Quality**

The Buckskin Mountain area is classified as a Class II airshed, with good to excellent air quality in the planning area. Air quality is regulated by the Utah Department of Environmental Quality, and is affected primarily by sources outside of the area. Emissions from coal-burning electric plants and vehicles in metropolitan areas to the west and southwest periodically reduce air quality. Additionally, air quality may be reduced on a temporary basis by wildland fire, wildland fire use, and prescribed fire within the area. In addition wildland and prescribed fires in this area has the potential to impact Class I airsheds and influence regional haze in areas such as Glen Canyon National Recreation Area, Grand Canyon, Zion and Bryce National Parks.

**Soils**

Soil is the basic resource of the ecosystem, and is the key to the productivity of an area. Based on the NRCS Soil Survey map,[10] soils in the project area are predominately derived from limestone parent material, in eleven soil map units[11] (Map 4, Table 3). All of the soils are well drained. The texture in the control section of the soil profile is loam in all of the soils except map unit 5172 which has loam and silt components.

Because a large portion of the Buckskin area was described as highly variable, and was not mapped in detail, additional soil pits were dug and described.[12] Generalizations from these soil pits were that pinyon-juniper woodland pits had shallower soils, more gravel and tended to have more loamy soils; and sagebrush desertscrub pits had deeper soils, less gravel, and mixed textures (clay, sandy loam, loamy, etc.).[13] All plots except three were highly effervescent (calcium carbonate content). The three remaining sites had no calcium carbonate content.

Increasing human activities in the project area have led to increased levels of soil disturbance and reduced soil productivity. Three management activities have had the most direct impact on soils of the project area: livestock grazing, road building, and fuel wood harvest associated activities.

Livestock grazing has impacted soils in localized areas of concentrated use, such as watering areas, salt block locations, springs, and open meadows. Compaction by livestock occurs anytime soils are moist and prone to compaction or in areas of concentrated use. Compacted soils are typically less productive than un-compacted soils.

Road building affects soils by removing and displacing the topsoil layers from the road prism and compacting the road surface and shoulders. The surface of the road will not support vegetation as long as the road is used and maintained. Trees and shrubs will grow along the road bank, but site productivity is less than in unaffected soils. Native surface roads (unpaved) will grow vegetation again when use and maintenance ceases. However, site productivity would be significantly less than similar undisturbed soils. Roads also disrupt hydrologic

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[8] Buckskin Mountain Assessment project record document No. 71.
[9] Buckskin Mountain Assessment project record document No. 72.
[10] Buckskin Mountain Assessment project record document No. 56, from m:/susadata/ph_shysil/s24/gsesoil030703
[11] Buckskin Mountain Assessment Project Record document No. 53, 175
[12] Buckskin Mountain Assessment Project Record document No. 181 and 182
[13] Buckskin Mountain Assessment Project Record document No. 183

processes that occur within the soil profile. The road prism interrupts the lateral down slope, subsurface water flow. This water accumulates in the road ditch, if present, or the road surface. If sufficient water accumulates, erosion can cause gullying, or movement of sediment. Impacts from roads persist until the road is totally reclaimed, subsurface drainage patterns restored and organic matter again accumulates on the surface. Site productivity will remain somewhat less on reclaimed roads than on similar undisturbed sites for a period of time. The project area exhibits roads with gullies and improper drainage.

Mechanized activities associated with pinyon or juniper harvest and vegetative manipulation can disturb soils in the following ways: soil loss due to erosion, displacement, compaction, puddling, removal or disturbance of organic matter, and elimination of large log component. Displacement can occur when the upper layer of soil is removed or mixed with underlying layers during harvest or other site disturbance. One of the most common causes of displacement is for heavy equipment to displace soils when turning. Compaction occurs when equipment breaks down soil structure, and thereby reducing the pore space within the soil. This happens most commonly when machinery (trucks, dozers, skidders, mechanized fallers/shredders) make repeated passes over the same ground or during times of high soil moisture. Puddling severely limits the infiltration of water. Compaction, puddling, removal or disturbance of organic matter, removal of large log component, loss of soil due to erosion, and displacement lessen site quality and soil productivity. The project area, due to fuel wood harvest and hunting activities, has off road vehicle use that has led to compaction, erosion, puddling, and reduced vegetative and litter cover.

**Hydrology**

There is very little surface water in the Buckskin Mountain analysis area due to the low annual precipitation, small catchment size and limestone geology. The Kaibab Uplift, which created Buckskin Mountain, resulted in the exposure of a thick layer of northwest dipping limestone. Ephemeral drainages have carved canyons through the limestone and numerous karst sinks are present throughout the Mountain. Sinkholes result from dissolution of carbonate lithologies, and hold water if underlain by a locally impermeable unit. The majority of these sinkholes do not hold water, and those that do are not a reliable long-term source of free water. The minimal amount of natural surface water within the planning area is found in sinkholes. Runoff from intense summer rainstorms or rapid snowmelt may produce streamflow that would run off into the deeper soils located to the northwest at the base of Buckskin Mountain or collect briefly in the sinks. There are two weather stations within or near to the analysis area. For the past water year, the annual precipitation totals in inches were 6.8 on Buckskin Mountain and 4.5 at Telegraph Flat. The majority of this precipitation falls during the winter months with summer monsoons adding another spike in the total. These numbers do not represent long-term averages; however the 100 year record in Kanab indicated that this past water year was close to average in annual precipitation.

Groundwater flow pattern and direction in karst is hard to predict and can flow contrary to the dip of the bedrock. In general, water in the subsurface layers moves down through a karst drainage network in the Kaibab and Toroweap formations, until it reaches semi-permeable layers or joints and fractures in the rock that permit lateral flow. Eventually flows could be intercepted by canyons and outcrop as springs. Water that does not outcrop in these locations continues downward and southward until outcropping in the Grand Canyon or Paria Canyon.

**Watersheds**

The Buckskin Mountain Analysis area straddles two watersheds, both of which drain into the Colorado River system. Approximately 1/3 of the analysis area drains northwest into White Sage, a sub watershed of the Kanab Creek Watershed. The rest of the analysis area drains northwest into the Buckskin Gulch Watershed which in turn drains into the Paria River. The analysis area makes up a very small percentage of the White Sage and Buckskin Watersheds, 0.8% and 0.6% respectively.

Runoff causes soil movement, and is the primary mechanism shaping pinyon-juniper landscapes.[14] Runoff occurs in pinyon-juniper woodlands due to topography, soil type, and vegetation structure. Pinyon and juniper trees often grow on steep slopes and rocky outcroppings, and in shallow soils that have little permeability. Since understory vegetation is typically sparse, ground cover is often inadequate to prevent water movement or stabilize soils. Erosion is usually minimal beneath tree crowns, where litter accumulates and the soil is protected from raindrop impact, but may be high in intercanopy spaces. Sheet erosion is common in the planning area. Soil erosion leads to decreased site productivity and impaired watershed function.[15]

B. Biological Environment

**Vegetation**

Community Composition

Vegetation within the Assessment area is classified as Great Basin Conifer Woodlands[16], Great Basin Desertscrub[17] and Great Basin Grasslands[18]. For this assessment we will focus on the Woodland and Desertscrub portions.

*Woodlands*

Woodlands occur on the Buckskin area in a band approximately 5075-6447 feet in elevation (See Map 5). Pinyon (*Pinus edulis*) is more common at higher elevations, and intermixes with Gambel's oak (*Quercus gambelii*). Utah juniper (*Juniperus osteosperma*) dominates at lower more xeric elevations, with juniper-savannas occurring along sagebrush-grassland ecotones. Overall, the composition of pinyon and juniper within the planning area is more heavily dominated by Utah juniper. Utah juniper is a long lived species that may live as long as 650 years.[19] Utah junipers have a taproot that extends deep into the soil (as far as 15 feet) and lateral roots that may extend as far as 100 feet from the tree, several inches below the soils surface. Most root biomass is within the first 3 feet of soil, with fine roots concentrated in the uppermost 18 inches,[20] or just below the soils surface.[21] Utah juniper responds to low nutrient levels in the soil by developing extensive networks of fine roots at the base of the tree and at the end of lateral roots. These roots are in part responsible for the competitiveness of juniper verses understory species.[22] Junipers compete more effectively for soil moisture

[14] Wilcox 1994
[15] Baker et al. 1995
[16] Pages 52-57 in Brown 1994. See Project Record document number 69.
[17] Pages 145-155 in Brown 1994. See Project Record document number 75.
[18] Pages 115-121 in Brown 1994. See Project Record document number 76.
[19] Loehle 1988 as cited in FEIS, See Project Record document 58-i
[20] Skau 1960 as cited in FEIS, See Project Record document 58-i
[21] Tiedemann 1987 as cited in FEIS, See Project Record document 58-i
[22] Johnson 1987, Klopatek. 1987 as sited in FEIS, See Project Record document 58-i

than do herbaceous understory plants, and overtime are more likely to maintain a stable population, while understory plants decrease.[23]

Woodlands for this region are described as tending to be rocky, with thin soils predominating.[24] It occurs on the mountain gradient above and within Great Basin desertscrub. Big sagebrush is the principle and often the almost exclusive understory plant. Other associates of general or regional importance are rabbitbrush (*Chrysothamnus spp.*), winterfat (*Ceratoides lanata*), shadescale (*Atriplex confertifolia*), and black sagebrush (*Artemisia nova*).

In the upper elevation range of woodland habitats, pinyon pine becomes a component of the woodland community. Pinyon is also a slow-growing, long-lived tree[25] that can survive more than 500 years.[26] Moisture is likely the most critical factor controlling the distribution, composition, and density of pinyon.[27] Important plant associates are Gambel's oak (*Quercus gambelii* – in shrub form), mountain-mahoganies (*Cercocarpus montanus*, *C. ledifolius*, *C. intricatus*), skunkbush (*Rhus trilobata*), serviceberry (*Amelanchier spp.*), snowberries (*Symphoricarpos spp.*), and currants (*Ribes spp*.). Other shrubs generally important as subdominant associates in woodland include cliffrose (*Purshia stansburyianna*), Apache plume (*Fallugia paradoxa*), Mormon tea (*Ephedra viridis* and others), barberry or Alberita (*Berberis fremonti* and *B. haematocarpa*), fourwing saltbush (*Atriplex canescens*), buffalo-berry (*Shepherdia spp*.), antelope bitterbrush (*Purshia tridentata*), fernbush (*Chamaebatiaria millefolium*), small soapweed (*Yucca glauca*), and dátil or banana yucca (*Yucca baccata*).

*Sagebrush Desertscrub*

Desertscrub occurs on the Buckskin area below and intermixed with woodlands at elevations ranging from 4845 to 5990 feet in elevation (See Map 5). Dominant shrub species in this type include big sagebrush (*Artemisia tridentata*), black sage (*Artemisia nova*), and broom snakeweed (*Gutierrezia sarothrae*). Higher elevations transition into shrub communities more heavily composed of cliffrose (*Purshia stansburyianna*) and big sagebrush mixed with Gambel's oak. The lower elevations in this type contain species such as winterfat (*Ceratoides lanata*), fourwing saltbush (*Atriplex canescens*), and rabbitbrush (*Chrysothamnus* sp.). Overall, the composition of Desertscrub is most strongly dominated by big sagebrush.

Sagebrush (*Artemisia*) is arguably the most important genus of plant species in the western United States. The sagebrush biome is the largest semi-arid ecosystem in the western United States.[28] Sagebrush taxa occur on an estimated 269 million acres (109 million ha) in the region. Artemisia is comprised of 200 – 300 species that are distributed throughout the world's temperate climates. The sagebrush that generally are most important are those that are widely distributed and/or dominate their communities. Their domination is natural due to their adaptation for many of the environmental conditions present in the western United States. These dominant sagebrush taxa are in the natural section Tridentatae of *Artemisia*, which is an endemic group to western North America.[29]

The most common species is big sagebrush (*Artemisia tridentata*). The genus and species for big sagebrush was given by Nutall in 1841 to a specimen collected by him on the Snake River plain. Big sagebrush is also

[23] Austin 1987; Everett et al. 1983; Springfield 1976, as cited in FEIS, See Project Record document 58-i
[24] Pages 52-57 in Brown 1994. See Project Record document number 69
[25] Gottfried 1992; Graves 1917; Little 1977
[26] Barth 1980; Erdman 1969; Floyd et al. 2000; Graves 1917; Swetnam and Brown 1992
[27] Gottfried 1987
[28] Miller and Eddleman 2001
[29] Wambolt 2001

the most important sagebrush species due to the large areas its subspecies occupy and often dominate under natural conditions. Although the subspecies may occasionally be found growing together, generally they require different environmental conditions. Understanding of these requirements provides insight to the ecological variation that exists among the many communities occupied by big sagebrush.[30]

Upon review of 29 journals and diaries written prior to the onset of heavy immigrant movement into the western United States and before the vegetation along major trails was grazed by domestic animals, Vale concluded that the pristine vegetation of the region was usually dominated by shrubs and that stands of grass were largely confined to mesic locations such as valley bottoms and canyons.[31] Vale stated "the original condition of the range has implications for management. As brush was abundant in times prior to livestock grazing, its dominance of the vegetation today cannot always be considered evidence of over-grazing". Moreover, attempts to eradicate brush and encourage pure stands of grass cannot be justified in terms of reestablishing the "natural plant cover".[32]

There are three widely recognized subspecies of big sagebrush (see Table 4). These are Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), basin big sagebrush (*A. t.* ssp. *tridentata*), and mountain big sagebrush (*A. t.* ssp. *vaseyana*). Subspecies can be separated on morphological, chemical, and ecological characteristics.[33, 34] Of the three big sagebrush subspecies, only Wyoming and basin big sagebrush are found on the Buckskin.

It has often been stated that land occupied by basin big sagebrush could be farmed. That is the case because this subspecies occupies deep, well drained soils usually found in valley bottoms or other locations where such soils occur. At the other extreme among the big sagebrush taxa, Wyoming big sagebrush occupies the most xeric locations among the taxa. These sites are usually the product of shallower soils and a large amount of clay or sometimes silt in the profile. The taxon does not do well on coarse-textured soils. The actual range of soils occupied by basin big sagebrush ranges from sandy through silty and clayey textures, and may often be cobbled. However, generally finer textured soils appear to be favored by the taxon. .[35]

Along the gradient between dry valley floors with precipitation of less than 160mm of moisture per year to mesic mountain tops with double or triple the valley precipitation the three subspecies each carve out a niche. *Artemisia tridentata* ssp. *wyomingensis* is at the low, dry end of the spectrum. *A. tridentata* ssp. *vaseyana* is at the high, moist end, and ssp. *tridentata* is intermediate.[36] Subspecies *tridentata* is the tallest of the three subspecies (generally >1.5m), *wyomingensis* is the shortest (generally <0.5m), and *vaseyana* is intermediate in height. *Vaseyana* also differs from the other two subspecies in that the inflorescence arise from the upper crown and extend above the vegetative structures giving the plant a flat-topped appearance.[37]

Hybrids between basin big sagebrush and mountain big sagebrush have been confirmed. [38] Hybrid zones exist between these 2 subspecies in parts of Utah. This zone is generally less than 0.6 miles (1 km) and in some

[30] Wambolt 2001
[31] Vale 1975
[32] Wambolt 2001
[33] Francis, 2002
[34] Welch, 2003
[35] Wambolt 2001
[36] Kolb and Sperry 1999
[37] Kolb and Sperry 1999
[38] McArthur et al. 1998, Graham et al. 1995

locations, less than 330 feet (100 m) wide. Hybrids between basin big sagebrush and mountain big sagebrush are intermediate for all character and exhibit considerable genetic variation.[39]

In addition to big sagebrush subspecies, black sagebrush (*Artemisia nova*) was found in the assessment area in the higher elevation zones. Black sagebrush is considered a subshrub or dwarf sagebrush that ranges from 15-20 cm tall. The elevation range for black sagebrush is 1,500 to 2,400 m.[40] Black sagebrush is most often found on shallow argillic or clay pan soils, except at higher elevations where the soils are calcareous to the surface and soils are limestone derived[41]. Because of these soil features, black sagebrush must survive highly saturated soils in the springtime and extremely dry soils in the summer. Although black sagebrush is most frequently found in the limestone derived soils of the assessment area, it is also adapted to a variety of soil types. For this reason it is recommended for use in restoration/site rehabilitation in areas that receive less than 6.9 inches of rainfall. It also establishes more readily from seed than big sagebrush.[42] Black sagebrush is an important browse species, particularly in the lower portion of the Great Basin Desert. It is a highly palatable and nutritious winter forage species, second only to big sagebrush.[43]

*Plant Species*

197 vascular plant taxa have been confirmed for the Buckskin Mountain area from US Highway 89 south to the Arizona state line and from Buckskin Gulch west to the GSENM boundary. An additional 101 plant taxa are known from just outside the study area in the vicinity of Five-mile Mountain and north of US Highway 89 and are likely to be found within the project area with additional survey[44]. The dominant woodland tree species are Colorado pinyon and Utah juniper. Dominant mid-story shrub species are big sagebrush (*Artemisia tridentata*), Gambel's oak, and cliffrose (*Purshia stansburiana*). Other common shrubs include black sagebrush (*Artemisia nova*), bitterbrush (*P. tridentata*), broom snakeweed (*Gutierrezia sarothrae*), four-wing saltbush (*Atriplex canescens*), rubber rabbitbrush (*Chrysothamnus nauseosus*), and prickly pear cactus (*Opuntia phaeacantha*). The dominant native grass species are blue grama (*Bouteloua gracilis*) and western wheatgrass (*Agropyron smithii*). These species are the most common grasses on impacted sites. Other native grasses include galleta (*Hilaria jamesii*), Indian ricegrass (*Oryzopsis hymenoides*), muttongrass (*Poa fendleriana*), needlegrass (*Stipa* spp.), and squirreltail (*Sitanion hystrix*). Crested wheatgrass (*Agropyron desertorum*) is a common seeded non-native species. Common forbs include globemallow (*Sphaeralcea parvifolia*) and yellow sweet clover (*Melilotus officinalis*), which is a non-native.

No Threatened or Endangered plants are thought to occur within the planning area; however several Utah Sensitive plant species may occur. Sensitive species that are associated with pinyon-juniper woodlands and sagebrush shrublands in the Buckskin area include Atwood's pretty phacelia (*Phacelia pulchella* var. *atwoodii*), Cutler's lupine (*Lupinus caudatus* var. *cutleri*), Four-stamen camissonia (*Camissonia exilis*), Gooseberry-leaf globemallow (*Sphaeralcea grossulariifolia* var. *fumariensis*), and Kane breadroot (*Pediomelum epipsilum*). One atypical population of Smoky Mountain globemallow (*Sphaeralcea fumariensis*) has been reported from limestone-derived soils in the Pine Hollow Canyon area of Buckskin Mountain.[45]

[39] Tirmenstein 1999
[40] McArthur et al. 1979
[41] Winward 2004
[42] Plummer et al. 1968
[43] Behan and Welch 1986
[44] Buckskin Mountain Assessment Project Record Document number 172.
[45] Buckskin Mountain Assessment Project Record document No. 172

Approximately 30 other rare plant species from Buckskin Mountain or its vicinity are tracked as species of special concern by the Utah Division of Wildlife Resource's Utah Conservation Data Center.[46]

At least 25 non-native vascular plants are known from the Buckskin project area and another four exotic species are likely to be discovered with additional survey. Four non-native plants are listed as noxious weeds under Section 4-17-3 of the Utah Noxious Weed Act (Russian knapweed (*Centaurea repens*), bindweed (*Convolvulus arvensis*), Scotch thistle (*Onopordum acanthium*), and Johnson grass (*Sorhgum halepense*).[47]

Some of the most ecologically significant weed species present in the Buckskin project area are not legally designated as "noxious". The most deleterious of these is probably cheatgrass or downy brome (*Bromus tectorum*), an annual grass which has become established throughout the study area (especially in decadent big sagebrush stands). Other annual weed species that may contribute to increased fire risk or which displace more edible forbs or grasses in disturbed sites of Buckskin Mountain include musk-mustard (*Chorispora tenella*), storksbill (*Erodium cicutarium*), bur buttercup (*Ranunculus testiculatus*), and tumbling mustard *(Sisymbrium altissimum*). Woolly mullein (*Verbascum thapsus*) and dalmatian toadflax (*Linaria dalmatica*) are perennial forbs that have become established sporadically along US Highway 89. Horehound (*Marrubium vulgare*), a mostly inedible perennial weed, has become well established throughout sagebrush-dominated areas of the Buckskin where it has replaced edible forbs. Tamarisk (*Tamarix chinensis*) has become established at a few sites on clay-rich soils in barrow pits along US Highway 89, the House Rock Valley Road, and GSENM Road 723, but is not especially significant in the Buckskin area.[48]

A more comprehensive list of vegetation that is likely to occur in the planning area is provided in Appendix B.

*Vegetation Data Results*

Detailed vegetation data was limited for the Assessment area, even for the distribution of covertypes. Map 5 shows the distribution of covertypes for the Assessment area based on the state-wide GAP data. This scale was not detailed enough, nor did it agree with other sources of vegetation cover data available, however gives a general idea of the community composition for the assessment area.[49] For data analysis purposes, the Assessment area was evaluated for two covertypes, sagebrush steppe and pinyon-juniper woodland. A vegetation sampling grid was randomly placed over the Assessment area (Map 6), and the sampling order was randomized. Vegetation data was collected in each cover type in the summer of 2003 and the results in terms of plant community composition are listed in the following paragraphs. For details on sampling grid,[50] sampling methods,[51] and sample size calculations[52] see the Project record. Buckskin Vegetation Results for 2003 Field Season are found in Appendix C.

*Pinyon-Juniper Dominated Sites*

In pinyon-juniper dominated sites the amount of litter had the highest cover followed by rock, bare ground, biological soil crusts, dead sagebrush and live sagebrush. In terms of woody species cover, live juniper trees had the greatest average cover at 16% (SE ± 2.1). Pinyon also had a relatively high cover at 6% (SE ± 2.5). Other common components included live sagebrush at 4% average cover (SE ± 0.86) and dead sagebrush at

[46] Utah Division of Wildlife Resources. 1998

[47] Buckskin Mountain Assessment Project Record document No. 172

[48] Buckskin Mountain Assessment Project Record document No. 172

[49] See Project Record document number 52 for a description of the various data available and evaluated. Also see documents 28 (SWA), 53 and 56 (NRCS Soils), 54 (VESWP), and 61 (soil_up7join2).

[50] Project Record document number 70

[51] Project Record document number 123

[52] Project Record document number 143 and 144

4% average cover (SE ± 1.3). The herbaceous understory of grasses and forbs was low at approximately 1% of the total vegetation cover. The average species richness across woodland sites was 6.3 species (SE ± 0.67). This reflects the total number of species observed in sample frames and is not a complete count of plants in the larger plot area.

*Sagebrush Dominated Sites*

In sagebrush dominated sites, the parameter with the greatest cover was bare ground followed by litter, rock, biological soil crusts, live sagebrush, and dead sagebrush. The amount of vascular understory species, such as grasses and forbs, was approximately 1% of the total vegetation cover. In terms of woody species cover, big sagebrush had the greatest average cover at 13% (SE=2.5, $s^2$=96.0) followed by dead sagebrush cover at 7% (SE=1.4, $s^2$=30.8). The average species richness across sagebrush sites was 6.9 species per plot (SE=0.62, $s^2$=6.2). This reflects the total number of species observed in sample frames and is not a complete count of plants in the larger plot area.

Vegetation Structure

*Woodland*

Pinyon-juniper woodlands are among the most simply structured plant communities in the western United States.[53] They are characterized by a matrix of pinyon pine and juniper trees, with surrounding interspaces that range from dense herbaceous and shrubby vegetation to bare ground. The paucity of understory vegetation in interspaces has been attributed to trees sequestering nutrients beneath their canopies.[54] Ground cover beneath juniper canopies is typically also sparse because junipers produce chemical compounds that competitively inhibit germination of many herbaceous species. Conversely, some shade tolerant perennial grasses are more prolific beneath juniper crowns than in the surrounding interspaces.[55]

Mature stands (100 years or older) typically have high tree densities and sparse herbaceous understories.[56] They are considered by some to be climax communities that are approaching equilibrium with climatic conditions, but are viewed by others as decadent stands that exist in a retrogressive state.[57]

Relatively few snags are found in woodlands. This is due mainly to rapid rates of decay in pinyon snags, and growth characteristics that allow juniper to produce live branches despite death in a majority of the tree.[58]

Within woodland stands, juniper trees are more common in the larger size classes. They are usually the first to become established in an area, then are followed and replaced by pinyon.[59] A greater success of pinyon establishment has been observed in pinyon-juniper woodlands throughout the Southwest.

Over the last century, pinyon-juniper woodlands have expanded their range throughout the Western United States.[60] Woodlands have expanded to both higher and lower elevations, and tree densities and canopies have increased within stands.[61] This expansion is evidenced by pollen records obtained from packrat middens and

[53] Brown, 1994: 52
[54] Evams. 1988
[55] Pieper, 1990
[56] Miller et al., 1999
[57] Brockway et al., 2002
[58] Sainsbury 1995
[59] Ffolliot and Gottfried, 2002
[60] Johnsen, 1962; Tausch et al., 1981; Miller et al., 1995; Laycock, 1999; Tausch, 1999
[61] Tausch et al., 1981; Miller et al., 1995; Tausch, 1999

old pond sediments, tree age-class ratios, and historical documents and photographs.[62] Causes are thought to be fire exclusion, livestock grazing, climatic fluctuations, and other factors.[63]

On the East Kaibab Monocline (southeast of the Buckskin Mountains area, in Arizona) Shaw noted moderate expansion of pinyon-juniper into sagebrush-grasslands from the early 1900s.[64] Photographic comparisons from 1940 and 1994 revealed similar expansion on areas within the Arizona portions of the Buckskin Mountains and Kaibab Plateau on the North Kaibab Ranger District.[65]

*Sagebrush Desertscrub*

Sagebrush communities are regarded by many as steppe or shrub steppe because of the importance of grasses.[66] Grasses, if not eliminated by grazing, are important understory elements in distinctly shrub steppe communities. Increasingly to the south, however sagebrush may grow to the virtual exclusion of grasses even in areas that have never been grazed by domestic livestock,[67] and unlike related vegetation to the north, sagebrush communities lacking a significant graminoid component are not necessarily in a grazing disclimax.[68] The near absence of grasses has been attributed to climatic controls – i.e. the timing and amount of precipitation – the paucity of grasses being correlated with low annual precipitation, falling predominantly in the winter.[69]

Basin big sagebrush commonly grows in association with cheatgrass (*Bromus tectorum*), bluebunch wheatgrass (*Pseudoroegneria spicata*), Thurber needlegrass (*Achnatherum thurberianum*), needle and thread grass (*Hesperostipa comata*), Idaho fescue (*Festuca idahoensis*), and Sandburg bluegrass (*Poa secunda*).[70] Common shrub associates include broom snakeweed (*Guiterrezia sartohrae*) and green rabbitbrush (*Chrysothamnus viscidiflorus*). Basin big sagebrush is a climax dominant on semiarid sites in the Pacific Northwest, Great Basin, and in the Southwest.[71]

Seral communities within sagebrush series are heavily influenced by one or two forces, grazing and fire. Sagebrush foliage is not readily eaten by domestic livestock or native ruminants as it contains oils that inhibit microbial activity in rumens.[72] Avoidance of sagebrush results in reduction of more palatable grasses and forbs and an increase in sagebrush.

Conflicting information regarding the utility and palatability of sagebrush is easily found in the literature. It is important to remember that numerous factors play into the use of sagebrush by ungulates; including season of use, condition and availability of other forage plants, level of use, etc. Sagebrush taxa may be overused and damaged on big game winter ranges. Even the least preferred taxon of sagebrush will be heavily used if the other species are unavailable or not present. This is not surprising since sagebrush has been proven to be highly digestible and nutritious by many authors.[73] Should this and the previous paragraph be moved to the browse section?

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[62] Betancourt et al., 1993; Covington et al., 1994; Miller et al., 1995; Tausch, 1999
[63] West and Young 2000 as cited in Baker and Shinneman 2004
[64] Shaw 1999
[65] Reading 2002
[66] Young et al. 1976; Daubenmire, 1970
[67] Vale, 1975; Jameson et al. 1962
[68] Young et al, 1976
[69] Christensen, 1959; Cronquist et al. 1972
[70] Tirmenstein 1999
[71] Tirmenstein 1999
[72] Nagy et al. 1964
[73] Wambolt 1996

*Vegetation Data Results*

Vegetation sampling results from the summer of 2003 in terms of plant community structure are listed in the following paragraphs.

*Sagebrush Dominated Sites*

An average of 12 trees per plot were observed in sagebrush sites which converts to approximately 47 trees per acre. Juniper trees were the most predominant species. Juniper trees were most abundant in the young and mature age classes with dead and decadent age classes the least common category. This may be the result of a possible earlier movement and establishment of junipers in many of the plots. In sagebrush cover types, the greatest juniper DRC (diameter at root crown) was attained in the decadent age class with dead and mature trees close in size to the decadent trees. The similarity in DRC for junipers between the mature and dead/decadent categories may indicate that many mature trees are close to attaining decadence.

In terms of shrub density and structure in sagebrush sites, belt transects recorded an average of 5,976 shrubs per acre. The four most frequently occurring shrub species were big sagebrush, broom snakeweed, winterfat (*Krascheninnikovia lanata*), and rabbitbrush. The mean number of big sagebrush plants per acre in sagebrush cover type was 3626 (SE ± 583). The mean number of broom snakeweed plants per acre was 777 (SE ± 291), the mean number of winterfat plants per acre was 647 (SE ± 647), and the mean number of yellow rabbitbrush plants per acre was 453 (SE ± 421). The most common age class for shrubs in sagebrush sites was mature with 39% of all shrubs. Dead shrubs were 23% of the total, 17% were decadent, 16% were young, and 2% were saplings. Most of the dead and decadent shrubs were big sagebrush.

*Pinyon-Juniper Dominated Sites*

The average number of trees in the pinyon-juniper sites was 54 trees per plot which converts to approximately 221 trees per acre (See Appendix C for details). An average of 118 junipers, 86 pinyon, and 17 Gambel's oak were counted per acre. Juniper trees were most abundant in the young and mature age classes with dead and decadent age classes the least common category (Fig 1). Seedling and young age classes were the most common for pinyon trees, suggesting either an early seral stage for this species or suppression of development by junipers. Juniper trees tended on average to have a larger diameter at root crown (DRC) in pinyon-juniper sites than in sagebrush sites. Junipers in the pinyon-juniper cover type are likely older trees that have not been subjected to juniper management activities that typically occur in sagebrush sites, such as chaining and mechanical thinning.

In terms of shrub density and structure in pinyon-juniper sites, belt transects recorded an average of 3,673 shrubs per acre. The four most frequently occurring shrub species were big sagebrush, black sagebrush, broom snakeweed, and Gambel's oak. The mean number of big sagebrush plants per acre in the pinyon-juniper sites was 2557 (SE ± 550). The mean number of black sagebrush was 420 (SE ± 420). The mean number of broom snakeweed plants per acre was 184 (SE ± 97) and the mean number of Gambel's oak per acre was 161 (SE ± 7). The most common age class for shrubs in the pinyon-juniper sites was dead with 50% of all shrubs. Decadent shrubs were 20% of the total, 13% were mature, 12% were young, and 4% were saplings. Most of the dead and decadent shrubs were big sagebrush.

Browse Condition

Data collected on browse species in 2003 for deer included the form class or degree of availability to deer, age class, and the average leader length. Data collected in 2003 were summarized by pinyon-juniper and sagebrush sites, and are reported below.

*Form Class*

In both the sagebrush and pinyon-juniper sites, form class 1 (all available, little to no hedging) was the most commonly observed category of browse.

*Age Class*

In sagebrush sites, decadent browse was the most commonly observed category at 33% (SE=0.06, $s^2$=0.06). Mature browse was slightly lower at 30% of all browse (SE=0.06, $s^2$=0.07). Pinyon-juniper sites also had decadent browse as the highest category but at 46% (SE=0.08, $s^2$=0.15).

*Leader Length*

The average leader length in sagebrush cover types was 6.68 millimeters (mm) (SE=1.0, $s^2$=16.8). The average leader length in the pinyon-juniper cover type was 9.97 mm (SE=3.4, $s^2$=242.8).

*Utilization*

In the early spring of 2004, utilization was collected. In general, utilization in both the pinyon-juniper and sagebrush sites was in the lower (0 and 1-10%) categories (Fig. 2), but a majority (70% in pinyon-juniper sites; 97% in sagebrush sites) of this use was on sagebrush (*A. nova* and *A. tridentate*) (Table 5; Fig. 3 and 4).[74] This is not too surprising in that most of the browse plants available are sagebrush (Fig. 5).

**Wildlife**

Pinyon-juniper woodlands and sagebrush desertscrub provide important habitat for many species of wildlife. The species discussed in the following sections are a representative sample of those that are present or presumed to be present in the area. Appendix D provides a more comprehensive list of wildlife species that potentially occur within the area. There are approximately 413 species that may be present on the Buckskin Mountains, including 10 amphibian, 288 bird, 86 mammal, and 29 reptile species.[75]

Sagebrush provide needed habitat components for scores of organisms, both plant and animal.[76] Sage grouse (*Centrocercus urophasianus*), mule deer (*Odocoilus hemionus hemionus*), and pronghorn (*Antilocapra americana*) eat considerable amounts of big sagebrush. Domestic sheep, pronghorn, and mule deer are known to consume both the leaves and stems of big sagebrush. Adult winter sage grouse diets may consist solely of big sagebrush leaves.[77]

Invertebrates

This assessment does not attempt to address the current or desired condition for invertebrate species in the Assessment area. However, the effects of proposed management activities on invertebrates may need to be considered because they serve as an important prey base for many other wildlife species and provide many services that are essential to ecosystem function.

[74] Buckskin Mountain Assessment project record document No. 177
[75] Buckskin Mountain Assessment project record document No. 165.
[76] Wambolt 1998
[77] Welch 1987

Amphibians and Reptiles

Few amphibians have been noted in the Assessment area and few are suspected, since surface water is scarce and little to no moisture is available in the soil. Tiger salamanders (*Ambystoma tigrinum*) occur where surface water is available and nearby under rotting downed logs that hold moisture. Toads are noted as common in available surface water at low elevations. Great Basin spadefoot (*Scaphiopus intermontanus*), red-spotted (*Bufo punctatus*) and Woodhouse's (*B. woodhousii*) toads are likely to occur in surface water in pinyon-juniper within the planning area. Tiger salamanders and Great Basin spadefoot toads are also likely to occur in surface water in the sagebrush areas.

Reptiles that are known to exist within the planning area include whiptail (*Cnemidophorus sp.*), short-horned lizards (*Phyrynosoma sp.*), collared lizards (*Crotaphytus collaris*), side-blotched lizards (*Uta stansburiana*), gopher snakes (*Pituophis melanoleucus*), Great Basin rattlesnakes (*Crotalus viridis lutosus*), and wandering garter snakes (*Thamnophis elegans*). See Appendix D for a more complete list of possible species.

Fish

Habitat for fish within the Assessment area is poor, since there are no perennial streams and surface water is generally unreliable as a permanent source. Therefore, no fish are expected to occur within the Assessment area.

Birds

*Songbirds*

Birds make up the majority of the wildlife species found in the Buckskin Mountains. 288 species are expected to use the area, including four federally listed and 17 state sensitive species. 108 bird species utilize pinyon-juniper woodland and 82 species utilize sagebrush.

Balda and Masters identified five avian species that are restricted to pinyon-juniper woodlands.[78] Four of these species are songbirds; the other is a raptor, the screech owl (*Otus kennicottii*). Songbirds include the gray flycatcher (*Empidonax wrightii*), gray vireo, (*Vireo vicinior*), juniper titmouse (*Baeolophus ridgewayi*), and scrub jay (*Aphelocoma californica*). These species are assumed to occur in the Assessment area.

The following birds are semi-obligatory (i.e., nesting within one other habitat type) or are closely associated species that use the woodlands as seasonal habitat. These include the ash-throated flycatcher (*Myiarchus cinearascens*), Bewick's wren (*Thyromanes bewickii*), black-chinned hummingbird (*Archilochus alexandri*), black-chinned sparrow (*Spizella atroqularis*), black-throated gray warbler (*Dendroica nigrescens*), blue-gray gnatcatcher (*Pilioptila caerulea*), bushtit (*Psaltriparus minimus*), house finch (*Carpodacus mexicanus*), lark sparrow (*Chondestes grammacus*), northern mockingbird (*Mimus polyglottos*), and spotted towhee (*Pipilo maculatus*).

The widespread distribution of junipers is thought to be due in part to foraging habits of many of the above species.[79] Additionally, several birds are of particular interest, since they have played a major role in the reproductive biology, evolutionary development, and present-day distribution and abundance of pinyon trees. A mutualistic relationship exists between pinyon pines and Clark's nutcrackers (*Nucifraga columbiana),* pinyon jays (*Gymnorhinus cyanocephalis*), scrub jays, Steller's jays (*Cyanocitta stelleri*), and black-billed

[78] Balda and Masters 1980; Masters 1979

[79] Balda and Masters 1980

magpies (*Pica pica*). The trees provide the birds with important forage and the birds act as dispersal agents for seeds through defecation or seed caching.

"The Sagebrush Sea" lists many bird species that use sagebrush habitats.[80] Of those species expected in the Buckskin Mountains, 169 species are indicated to use sagebrush habitats.

*Game Birds*

Pinyon-juniper woodlands provides important habitat for several species of game birds. These species include Merriam's turkey (*Meleagris gallopavo merriami*), band-tailed pigeon (*Columba fasciata*), and mourning dove (*Zenaida macroura*). Pinyon trees provide an important source of mast for these species, and Merriam's turkey is particularly dependent on them during winter. Sagebrush desertscrub provides important habitat for game birds as well. Native Gambel's quail (*Callipepla gambelii*) and non-native Chukar (*Alectoris chukar*) may be present within the assessment area. It should be noted that sage grouse (*Centrocercus urophasianus*) was probably historically present in the sagebrush communities adjacent to the woodland habitat in this Assessment area. No known sage grouse currently inhabit the area. The closest known sage grouse lekks are located in Johnson Canyon, approx. 15-20 miles to the northwest. Big sagebrush comprises a relatively small amount of sage grouse chick diets (about 15%). As chicks mature, they consume more sagebrush. Adult sage grouse diets are composed of 66% to 95% sagebrush in the fall.[81]

*Raptors*

Raptors found within the Assessment area include Cooper's hawks (*Accipiter cooperii*), ferruginous hawks (*Buto regalis*), red-tailed hawks (*B. jamaicensis*), American kestrels (*Falco sparverius*), golden eagles (*Aquila chrysaetos*), and great-horned owl (*Bubo virginianus*). Prairie falcons (*Falco mexicanus*), peregrine falcons (*Falco peregrinis*), Swainson's hawks (*B. swainsoni*), short-eared owl (*Asio flammeus*), long-eared owl (*Asio otus*), Burrowing owl (*Athene cunicularia*) and California condor (*Gymnogyps californianus*) may occur as well. The planning area may be visited on occasion by wintering bald eagles (*Haliaeetus leucocephalus*), rough-legged hawks (*Buteo lagopus*), northern goshawk (*Accipiter gentilis*) and sharp-shinned hawk (*Accipiter striatus*).

The Mexican spotted owl (*Strix occidentalis lucida*) is listed as a Threatened Species, according to the Endangered Species Act of 1973. Mexican spotted owls have been noted using pinyon-juniper woodlands during winter. However, woodlands provide poor quality habitat for this species unless associated with slot canyons. Suitable slot canyon habitat is not present within the assessment area. Therefore, the presence of Mexican spotted owls within the planning area is unlikely.

Mammals

*Small to Medium-sized Mammals*

The pinyon mouse (*Peromyscus truei*) is closely associated with the pinyon-juniper woodlands and is considered to be the characteristic mammalian species of this habitat type.[82,83] Pinyon mice are typically found in rocky areas within pinyon-juniper stands. They are strongly associated with pinyon trees, and are rarely found in stands of pure juniper. Pinyon tree canopy cover may be an important habitat feature for this species (Severson, 1986).

[80] American Lands Alliance 2003
[81] Welch 1987
[82] Page 31 in Hoffmeister 1986
[83] Pages 582-583 in Wilson and Ruff (eds) 1999

Other species of small to medium-sized mammals that are likely to occur within the Assessment area include the desert shrew (*Notiosorex crawfordi*), Great Basin pocket mouse (*Perognathus parvus*), Ord's kangaroo rat (*Dipodomys ordii*), long-tailed vole (*Microtus longicaudus*), deer mouse (*Peromyscus maniculatus*), brush mouse (*P. boylii*), bushy tailed woodrat (*Neotoma cinerea*), desert woodrat (*N. lepida*), cliff chipmunk (*Tamius dorsalis*), white-tailed antelope squirrel (*Ammospermophilus leucurus*), rock squirrel (*Spermophilus variegatus*), desert cottontail (*Sysvilagus audobonii*), mountain cottontail (*S. nuttallii*), black-tailed jackrabbit (*Lepus californicus*), white-tailed jackrabbit (*L. townsendii*), and common porcupine (*Erethizon dorsatum*).

*Bats*

Bats utilize habitat within the Assessment area for roosting and foraging. Open areas within woodland stands, areas near water, and those along sagebrush-grassland ecotones are likely to receive the most use as foraging sites. Mexican free-tailed bats (*Tadarida brasiliensis*), long-legged myotis (*Myotis volans*), fringed myotis (*M. thysanodes*), and Allen's lappet-browed bats (*Idionycteris phyllotis*) are common in pinyon-juniper woodlands.[84] Additionally, long-eared myotis (*M. evotis*) often roost in folded bark and wood of junipers, juniper stumps, and small groups of rocks in pinyon-juniper. These species are likely to occur in the Assessment area. Bats that utilize sagebrush-grasslands along woodland edges and that may be found within the Assessment area include big brown bats (*Eptesicus fuscus*), big free-tailed bats (*Tadarida macrotis),* California myotis (*Myotis californicus*), western small-footed Myotis (*M. ciliolabrum*), hoary bats (*Lasiurus cinereus*), little brown bats (*M. lucifugus or M. occultus*), pallid bats (*Antrozous pallidus*), silver-haired bats (*Lasionycteris noctivagans*), Townsend's big-eared bats (*Corynorhinus townsendii*), western pipistrelles (*Pipistrellus hesperus*), and Yuma myotis (*M. yumanensis*). From recent radio telemetry work on the Arizona Strip, spotted bats (*Euderma maculatum*) utilize woodland and sagebrush habitat for foraging,[85] and may be found in the area.

*Big Game*

The Buckskin Mountains (Utah and Arizona portions) provides important habitat for Rocky Mountain mule deer (*Odocoileus hemionus*) during winter and during spring and fall migrations. This area is used by two highly prized deer herds: the Pausaugunt (to the north) and the Kaibab (to the south) mule deer herds. The best estimate of the area of overlap between these two herds is an east-west band across the Buckskin Mountains beginning 4 km south of the state line and extending 9 km into Arizona.[86]

Mule deer that summer on the Paunsaugunt Plateau in southern Utah are referred to as the Paunsaugunt herd and are contained in Utah Division of Wildlife Game Management Unit 27. Most of the Paunsaugunt deer migrate to the south or southeast in the area generally between Kanab Creek to the west and Paria River to the east.[87] Southern migration movements are limited by topography to breaks in the almost vertical White Cliffs that separate the Skutumpah and Wygaret terraces, and again through the limited breaks in the Vermilion Cliffs that separate Wygaret Terrace from the valley to the south. Johnson Canyon and Deer Springs Wash may be primary routes through the White Cliffs for mule deer traveling to and from winter range. Kanab Creek may also be a route through the White Cliffs from Wygaret Terrace. Carrel et al. estimated that approximately 20-30% of the Paunsaugunt herd crosses US 89 (Interstate herd), and found that 90% of mule deer that migrated across US 89 did so between mile markers 39-42 and 49-51. They then travel to and through the Assessment area. During spring migration, deer appeared to use an area west of Deer Springs Wash between US 89 and Vermilion Cliffs as a staging area during spring migration, before continuing on to summer range. Carrel et al.

[84] Chung-MacCoubrey 1996
[85] C. Chambers Pers. Comm. 2003
[86] Carrel et al. 1999
[87] Carrel et al. 1999.

also found that 12.9% of Interstate deer mortality was due to deer-vehicle collision. UDWR target population size for the Paunsaugunt Deer Herd is 6,500 wintering deer (modeled number) with a post season buck to doe ratio of 30:100, with 50% of these bucks being three point or better.[88]

Mule deer that live on the Kaibab Plateau and surrounding areas are collectively referred to as the Kaibab deer herd, and are contained in the Arizona Game and Fish Department Game Management Units 12A and 12B. A majority of the Kaibab herd winter on the eastern and western portions of the Kaibab Plateau, however a small portion utilize habitat within the Buckskin Mountains. The Kaibab herd is well known among hunters for having deer with large antler sizes, and is infamous in wildlife management for its history of population oscillations.[89] In 1906, President Theodore Roosevelt designated the North Kaibab Ranger District as the Grand Canyon Game Preserve. Subsequent to the designation of the preserve, management activities such as hunting prohibition and predator control were initiated to encourage growth of the deer population.[90] During this time period heavy livestock grazing, which favored increases in woody browse species, was also occurring on the Kaibab Plateau. The combined effects of management activities and livestock grazing are cited as the major causes of deer population irruptions in the 1920's.[91] Browse use by the large deer herd soon exceeded annual growth, and severely impacted range conditions. Several droughts and severe winters then led to major die-offs of deer in 1924 and 1955.[92] Fire suppression, which may have accelerated loss of available browse, has also been indicated as a factor contributing to these die-offs.[93,94] Reversals in hunting and predator control policies have allowed deer populations to recover to levels which fluctuate within relatively stable limits. However, forage conditions continue to be problematic and after several years of severe drought the herd is again in danger of a die-off.

Pronghorn (*Antilocapra americana*) prefer grassland prairie habitat, but infrequently use open pinyon-juniper woodlands.[95] They may be found in juniper-savanna habitats within the planning area, and sagebrush-grassland ecotones where big sagebrush is not too dense. The Buckskin area may have limited use by pronghorn, but may have occasional use from the herd found in the White Sage Flat and Johnson Run areas to the southwest of Buckskin. Pronghorns require long sighting distances to evade predators and avoid areas with dense shrubs and woodland trees. Dense stands of pinyon-juniper may inhibit pronghorn movements and effectively isolate areas of suitable grassland habitat.

Basin big sagebrush may serve as emergency winter food during severe winter months, but it is not usually sought out by livestock or wildlife. Researchers point out that although big sagebrush is not preferred by wildlife, it is used when preferred plants are not available. Palatability of basin big sagebrush is "low,"[96] and basin big sagebrush is the least palatable of the three major subspecies.[97] Conflicting information regarding the utility and palatability of sagebrush is easily found in the literature. It is important to remember that numerous factors play into the use of sagebrush by ungulates; including season of use, condition and availability of other forage plants, level of use, etc. Sagebrush may be overused and damaged on big game winter ranges. Even the least preferred types of sagebrush will be heavily used if the other species are unavailable or not present. This is

[88] Appendix 17 *in* USDI Bureau of Land Management 1998
[89] Russo 1964
[90] Rasmussen 1941
[91] Mitchell and Freeman. 1993
[92] Russo 1964
[93] Gruell 1986
[94] Mitchell and Freeman 1993
[95] Ockenfels, et al. 1994
[96] McArthur et al. 1977; Tirmenstein 1999
[97] Owens and Norton 1990; Tirmenstein 1999

not surprising since sagebrush has been proven to be highly digestible and nutritious by many authors.[98] This is important on the Buckskin. If ungulates are using big sagebrush, it may indicate that the expected vegetation is in poor vigor, unavailable, or missing on the landscape.

*Carnivores*

Mountain lions are known to occur within the Assessment area, and are probably most abundant during winter when mule deer occupy the winter range. Populations were greatly reduced in the region during the early 1900's by predator control programs.[99] However, the current population is probably stable.[100] Sightings are rare, but this is to be expected, as mountain lions are elusive and secretive creatures.[101]

Other carnivores that are likely to occur within the Assessment area include the bobcat (*Felis rufus*), gray fox (*Urocyon cinereoargenteus*), ringtail cat (*Bassariscus astutus*), American badger (*Taxidea taxus*), and coyote (*Canis latrans*). Black bear (*Ursus americanus*) are rarely observed.[102] Limited suitable habitat for black bear exists within the Assessment area, but they are probably uncommon.

**Disturbance and other Processes**

Ecological processes play integral roles in ecosystem health and function. These processes shape ecosystems through change in species composition and relative abundance, and consequently influence ecosystem dynamics.[103] Major ecological processes include climate change, disturbance, succession, evolution, speciation, and natural extinction. The processes of climate change, evolution, speciation, and natural extinction operate on long time scales and their effects are relatively imperceptible within a human time frame. Because the processes of disturbance and succession tend to operate on shorter time scales, their effects are more apparent in the current landscape.

The processes of succession and disturbance are interrelated, since the main effect of disturbance is a shift in successional pathways.[104] Natural disturbances such as fire, weather, and disease can effectively "set back the clock" in many ecosystems to younger seral stages of vegetation. Such changes in vegetative structure result in the creation of landscape patterns.[105]

Past management activities often sought to suppress natural disturbances because they were perceived to negatively influence resources.[106] This resulted in a loss of biodiversity and impaired ecosystem function, which has contributed to larger and more severe disturbances in many ecosystems.[107] Land managers now recognize that disturbance is common in most systems, and is essential in maintaining proper function. Further, understanding the role of disturbance in an ecosystem is necessary to determine ecosystem potentials and identify possible outcomes of management activities. A discussion of potential disturbance factors in the Buckskin Mountain area is provided in the following sections in an attempt to promote such an understanding. This discussion includes disturbances that have occurred in recent history in addition to those that are currently occurring, and encompasses both natural and human-caused disturbances.

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[98] Wambolt 1996
[99] Rasmussen 1941.
[100] A. Bronson, pers. comm.
[101] Hoffmeister 1986:524, Wilson and Ruff 1999:226-228
[102] A. Bronson, pers. comm.
[103] Lugo et al., 1999
[104] Lugo et al., 1999
[105] White et al., 1999
[106] Covington et al., 1994
[107] Covington et al., 1994; White et al., 1999

Natural Disturbances

*Fire*

Dense pinyon-juniper woodlands with sparse herbaceous understories are considered virtually "fireproof" because there is little mechanism for fire to carry along the ground and spread through the stand.[108] For fire to carry, severe conditions are usually required. Consequently, fires are typically wind driven, high in intensity, and stand replacing.

Several high-intensity stand replacing wildfires have occurred within the planning area (Table 6). The most recent of these occurred in July of 1998 in the eastern portion of the buckskin, burning approximately 1110 acres. A large portion of this area (354 acres) was burned in July the previous year. Three small (<50 acre) fires also occurred in 1998. Another large fire took place in 1996 in a more central location of the Buckskin and was approximately 300 acres.

Much of the area Assessment area is approved for wildland fire use (Map 7).[109] The greatest proportion is Category C: fire is desired but constraints exist because of existing vegetation due to fire exclusion. Only a small portion in the northwest corner is Category D: Fire is desired.

*Weather*

Drought conditions have occurred within the Assessment area and much of the Monument over the last few decades. Pinyon pines have been particularly stressed by drought, and mortality has been observed throughout the woodlands. Large areas of sagebrush desertscrub have also died in the last few years, and is speculated to be due to stress from drought and insects.

Impacts of drought within the Assessment area are temporarily alleviated by periodic increases in precipitation that occur approximately every 3 to 5 years. This increased moisture is a result of the El Niño Southern Oscillation, a warm ocean current from South America that moves up the North American coast and alters weather patterns in the Pacific Ocean.

*Insects and Disease*

Pinyon needle miners (*Coleotechnites edulicola*) may be impacted pinyon trees within the Assessment area. Outbreaks of needle miners often coincide with drought conditions because stressed trees are more susceptible to insect attack. Note that while needle miner infestation has been recognized in nearby lands (North Kaibab Ranger District), the widespread pinyon mortality that has recently been observed in the Arizona Strip region and much of the southwest, is likely a direct result of drought stress rather than insect damage.[110]

Mistletoe infection may impact both pinyon and juniper trees within the Assessment area. Dwarf mistletoe (*Arceuthobium divaricatum)* parasitizes pinyon pine, and is spread to other trees through a forced ejection.[111] *Phoradendron* mistletoes infect juniper, and are spread by bird dispersal of seeds.[112] Mistletoes reduce vigor, viability, and reproductive success of host trees,[113] but convey important benefits to many wildlife species. Dwarf mistletoe induces excessive branching that results in structures known as witches' brooms.[114] Witches' brooms provide nesting, roosting, and foraging sites for many birds and mammals. In addition to providing

[108] Arnold et al., 1964
[109] Buckskin Mountain Assessment Project Record document No. 106.
[110] USDA 2003
[111] Weber et al., 1999
[112] Geils and Hawksworth, 2002
[113] Lei, 1999
[114] Geils and Hawksworth, 2002

important structural habitat for these species, dwarf mistletoe is used as forage. Since berries of *Phoradendron* mistletoes have high nutritional value, they are also an important source of forage for a variety of wildlife.[115]

Army cut-worms (*Euxoa auxiliaries)* were observed in large numbers in much of the southern portion of the monument in winter 2002/2003. It is speculated that large areas of sagebrush descertscrub were defoliated by these cut-worms.

Human-caused Disturbance

*Grazing*

Livestock are grazed within the Assessment area at controlled densities, using management systems designed to reduce impacts to the native ecosystem. However, livestock and wild ungulate grazing continues to have a role as a disturbance. Grazing may influence vegetative community composition through reductions in ground cover, and may contribute to the spread of noxious and invasive weeds. Additionally, grazing pressure in areas burned by wildfire may limit recovery of forage and browse species. The combined effects of these influences may contribute to unsatisfactory watershed conditions within the Assessment area.

*Fuelwood Cutting*

Personal fuelwood cutting is permitted within portions of the Buckskin Mountain Assessment Area (Note that it is not permitted in most areas of the Monument). Fuelwood cutters sometimes drive off of existing roads through wooded areas, disturbing soil and increasing the potential for erosion and the spread of noxious and invasive weeds. The current Buckskin Fuelwood Area boundary is difficult to follow as it does not follow any land features, roads, or fence lines on the ground.[116] This makes it hard to follow on the ground and to explain to the general public using the area to fill fuelwood permits. The current boundary is almost imposable to enforce, as the boundary crosses main travel routes in the area and does not follow any recognizable feature on the ground. Currently, if fuelwood is being cut in the in the general area, within a reasonable distance of the boundary, no action is being taken.

*Pinyon Nut Harvesting*

Native Americans from tribes in both Utah and Arizona utilize portions of the Assessment area to harvest pinyon nuts during years with good cone crops. Pinyon nut gatherers sometimes travel off-road through woodlands, and occasionally construct temporary brush shelters.

*Back-country Travel*

The Assessment area contains an extensive system of unmaintained social travelways. These are "roads" that have been created through other human activities like fuelwood gathering, hunting, and recreation. Where these social travelways cross drainages, their use contributes to soil erosion and site degradation. Use of social travelways may contribute to the spread of noxious and invasive weeds from disturbed sites to other areas.

## C. Human Dimension

The northern boundary of the Assessment area is Highway 89 which is a major travel corridor for both tourists visiting the Colorado Plateau Region and local inhabitants. This section of highway connects the towns of Kanab, Utah and Page, Arizona as well as popular tourist destinations such as Zion and Bryce Canyons National Parks, the North Rim of the Grand Canyon, and Glen Canyon National Recreation Area (Lake Powell). Those driving the highway derive pleasure from its scenery and views of distant and unusual geologic

[115] Urness, 1969, as reviewed by Geils and Hawksworth, 2002

[116] Buckskin Mountain Project Record document No. 14

formations. The Vermillion Cliffs can be observed on the north side of the highway. Views of landmarks in the southern portion of Grand-Staircase Escalante National Monument can be seen along this corridor.

Since humans exist as part of the ecosystem, it is necessary to incorporate the human component in any discussion of landscape conditions. Human values and beliefs will necessarily determine management activities that shape the landscape. There are many possible values that may influence management activities in pinyon-juniper woodlands. However, visual (or scenic) and resource values are likely to be some of the most important influences within the Assessment area.

**Visual Resource Management**

BLM uses a Visual Resource Management (VRM) system to inventory and manage visual resources on public lands.[117] The primary objective of VRM is to minimize visual impacts on BLM administered public lands. The VRM system uses four classes to describe the different degrees of modification allowed to the landscape. Visual Resource Management classes are based upon a landscape's visual quality, viewer sensitivity to that landscape, and comprehensive management objectives. Once an area has been assigned a VRM class, the classification is used to analyze the visual impacts of proposed projects and activities on BLM lands. The basic philosophy underlying the VRM system is that the degree to which a proposed project or activity affects the visual quality of a landscape depends on the visual contrast created between the proposal and the existing landscape. The VRM system's assessment process provides a means for determining visual impacts and for identifying measures to mitigate those impacts.

VRM classes were determined for Monument lands during the Monument Management Planning process and are included in the Monument Management Plan effective February 2000.[118] More than 95% of the Buckskin Mountain Assessment Area encompasses Monument lands classified as VRM Class III; the remaining lands are classified as VRM Class II (Map 8).

> The objective for VRM Class III is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the landscape.
>
> The objective for Class II is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.

**Visual Landscape Character**

As viewed along Highway 89, the project area consists primarily of flat to minimally rolling terrain which creates a panoramic landscape. The foreground is typically composed of a consistent mat of vegetation (sagebrush and grasses), with only random openings; the mid-ground and background are composed of solid expanses of pinyon-juniper with slightly irregular edges.

[117] Visual Resources Specialist Report, Buckskin Mountain Assessment project record document No. 180
[118] USDI. 1999. pgs 60-61

As viewed from interior roads on Buckskin Mountain, the landscape is rolling terrain in the foreground with either the undulating terrain of the Vermilion Cliffs or Paria Canyons in the background. Panoramic views are had from most locations. Random to dense stands of pinyon-juniper are prevalent in the foreground and mid-ground. In those areas where the stands of trees are adjacent to the road, the view is shortened to the immediate surroundings and has a sense of enclosure.

The lines in the landscape are strongly horizontal, particularly in the foreground and mid-ground. They are formed by the landform edges and the subtle differences in concentrations of the vegetation. When viewed from roads on Buckskin Mountain, the background is predominantly horizontal but with some rounded and diagonal lines along cliff and plateau edges as well as where vegetation composition changes.

The predominant colors of this landscape are grayish greens, tans, and reds. The greens run the spectrum of sage to dark green because of the vegetation. The reds are primarily vermilion and the tans are mostly buff, with some lighter and darker variations depending on the soil type and stone.

The texture of the landforms is primarily fine with some areas of medium where the landform is more varied in the background. The texture of the vegetation is smooth to medium, depending on the consistency of the vegetation spacing or where it changes from sagebrush to pinyon/juniper.

The visible structures within this landscape include Highway 89, fences, and power lines. The fences, power lines and their support structures (i.e. metal transmission tower or wooden poles) add vertical and horizontal lines to the landscape.

The Buckskin Mountains area is a classic pinyon-juniper landscape in Southern Utah which creates a feeling of vastness and open space similar to many areas within the Colorado Plateau region.

**Resource Values**

Pinyon-juniper woodland and sagebrush desertscrub communities within the Assessment area are valued by Native Americans from the Kaibab Paiute, Navajo, and Hopi tribes for resources such as medicinal plants, pinyon nuts, and fuelwood. Additionally, some tribes use the Assessment area for ceremonial purposes.

The woodlands are further valued for the recreational and hunting opportunities that they provide for a variety of users.[119] For example, residents of nearby communities appreciate fuelwood and Christmas tree cutting in the woodlands. Hiking has limited appeal in this area in as water and existing trails are limited. Two adjacent areas (Paria Canyon/Vermilion Cliffs Wilderness Area and Kaibab Gulch) are used extensively as hiking areas. Eagle Sink is an impressive geological feature and is a day use area for recreationists. In the future, designated dispersed, primitive dispersed and a developed campground may be developed in or near the Buckskin Mountain area.[120] Because of the trophy status of the Paunsaugunt deer herd, hunters appreciate the opportunity to hunt mule deer and the many game species that winter in woodland habitat.

Economic importance for the wood products resource on Buckskin Mountain is two-fold: those who rely on wood for personal use including household heating and fence posts, and those who harvest wood products commercially as an income source.[121] From a personal use perspective, fuel wood for household heating is the most important. 2000 census data show that nearly 25% of homes in Kane County and Kanab City rely on

[119] Buckskin Mountain Assessment Project Record document No. 147, Recreation Specialist Report
[120] Buckskin Mountain Assessment Project Record document No. 147
[121] Buckskin Mountain Assessment Project Record document No. 173

wood as a primary household heating source. The data do not show how many additional homes use wood as a supplemental heating source but empirical observation indicates nearly 70% of homes in Kanab have some type of outlet for wood burning device (chimney, stove pipe etc.) indicating at least some use of wood heat. While nearby Kaibab National Forest meets part of the need for fuelwood in the area, there is a high demand for fuel wood from Buckskin Mountain. In 2003 for example, BLM issued permits for over 200 cords of firewood. Buckskin has the advantage of being available for wood cutting year-round while the Kaibab is unavailable in late fall and winter.

There are several individuals who depend on the harvest of wood products from Buckskin Mountain as a sole or supplemental income source from the sale of firewood and wood posts. In 1999 for example BLM issued commercial permits for 150 cords of firewood. A similar number of wood post permits are also issued. Commercial operators will often haul fire wood in larger cities such as Las Vegas or Phoenix where wood will sell for more than $100 per cord. Another economic value of wood posts is to livestock operators on Buckskin for the construction or maintenance of livestock management fences negating the need to purchase products commercially.

Currently, there no active mines within the Assessment area. However, one material pit is present (3 acres along Highway 89; Legal description: T43S R3W Sec 4, S@NESW, L2). [122]

[122] Buckskin Mountain Assessment Project Record document No. 179

# CHAPTER 3

*HISTORIC LANDSCAPE CONDITION*

By investigating the historical ecology of the landscape, managers are better prepared to make inferences about modern conditions and the trends or trajectories that the modern ecosystem may experience.[123] This knowledge is essential for estimating potential outcomes of management activities. Further, historic conditions provide a glimpse of the factors that made the past ecosystem sustainable and allow possible causes of degradation to be identified.

Historic condition is defined in this assessment as the condition which existed prior to European settlement in the Southwest, which occurred in approximately 1870. This time period was chosen because it represents an era before modern land use practices (e.g., grazing and fire suppression) disrupted ecosystem processes. The following discussion is limited to landscape conditions that are assumed to have existed during the pre-settlement time period. A synthesis of the changes that have occurred since European settlement is provided in Chapter 4.

## A. Physical Environment

Slow processes that occurred over millions of years have formed and altered the geology, soils, and hydrology of the Assessment area. Numerous changes in the historic landscape have resulted from periodic events such as sedimentary deposition, geologic uplift, and canyon formation. Since these processes operate on long time scales, the geomorphology of the landscape that existed in the century or so prior to European settlement was probably very similar to the current landscape.

Changes in air quality and climate of the planning area have also occurred throughout history. Betancourt et al. present evidence of periodic change in carbon dioxide concentrations, temperature, and precipitation patterns across the southwestern United States.[124] Paleoecological evidence obtained from packrat middens, cave sites, and ancient pollen samples indicates that droughts were common during the last 40,000 years. Additionally, fluctuations between cooler/wetter periods and warmer/drier periods have occurred during the last 12,000 years.[125] These fluctuations in climate have been the major driving force of historic vegetation change within the planning area.[126]

## B. Biological Environment

Little information exists regarding the biological components of historic woodlands and desertscrub communities. This lack of information limits the ability to make inferences about overall community composition and the abundance and distribution of individual plant and animal species within the planning area.

[123] Egan and Howell, 2001: 6-8
[124] Betancourt et al., 1993
[125] Miller and Wigand, 1994
[126] Anderson et al., 2000

**Flora and Fauna**

The distribution of plant communities in the assessment area has probably changed periodically over the last several thousand years in response to the climatic fluctuations discussed in the previous section. In the West, woodlands have expanded and contracted, shifting south and down in elevation during cooler/wetter periods and back again with warmer temperatures.[127] Approximately 2600 years ago, pinyon-juniper woodlands began expanding their range throughout Arizona, in both an upward and downward elevational gradient.[128] Similar processes are expected for southern Utah. Pollen records indicate that this expansion has accelerated over time. However, discussion exists over the extent and rate of woodland expansion during the several hundred years prior to European settlement.

Significant changes in plant community structure and composition have occurred across the sagebrush biome and associated vegetation zones during the late 19th and 20th centuries.[129] Just prior to European settlement, plant communities in the sagebrush biome had developed under several hundred years of cold wet conditions (the Little Ice Age) and wetter and milder conditions during settlement from 1850 to 1916. Wyoming big sagebrush and low sagebrush cover types, with less frequent disturbance events but slower recovery rates, and the mountain big sagebrush cover type with more frequent disturbance but faster recover rates created a mosaic of multiple seral stages across the landscape. In addition, fire patterns were patchy, leaving unburned islands, particularly in Wyoming big sagebrush cover types because of limited and discontinuous fuels. Plant composition ranged from dominant stands of sagebrush to grasslands. However, a large portion of the sagebrush stepped ecosystem type was probably composed of open stands of shrubs with a strong component of long-lived perennial grasses and forbs. Current distributions of potential habitat for Greater and Gunnison sage-grouse (sagebrush steppe) in the West predict a major decline (approximately 10%) from presettlement distributions.[130]

Since understory species rarely leave a record of their occurrence, there is little information about the understory community of historic woodlands. Alcoze and Hurteau used paleoecological evidence and historic documents to construct a list of understory species that may have occurred in pinyon-juniper woodlands in the Greater Grand Canyon Region from 800 AD to approximately 1870.[131] In comparing the historic species list with modern species lists for the region, they found similar community compositions. They noted that several species were not found on modern landscapes, but declined to report them because the plants may indeed exist but are rare and remain undetected. Ongoing work in the region may provide more information about understory species composition, abundance, and distribution within the planning area.

The composition of the wildlife community that existed in the historic woodlands was undoubtedly determined by evolutionary processes. Species composition during the several hundred years prior to European settlement was probably similar to that which is found on the modern landscape. However, predators were much more abundant. (Control programs in the early 1900's led to the extirpation of the wolf and greatly reduced populations of mountain lions, bobcats, foxes, and coyotes.) Since these predators regulated mule deer populations, eruptions were unlikely and deer probably existed at densities within a more stable range than occurs on the current landscape.

[127] Covington et al., 1994; Miller and Wigand, 1994
[128] Davis, 1987 as cited by Covington et al., 1994
[129] Miller and Eddleman 2001
[130] Schroeder et al. 2004
[131] Alcoze and Hurteau, 2001

## Natural Disturbance and Human Influence

Many processes that operate on the modern landscape also operated in historic woodlands and desertscrub communities. However, natural disturbances likely operated at different spatial and temporal scales. Additionally, humans influenced the landscape in much different ways.

### Fire

Charred wood and fire-scarred tree stems indicate that fire was more common in historic pinyon-juniper ecosystems, and that it played a natural role in determining pinyon-juniper distribution and stand structure by influencing plant succession. Gruell suggested that fires occurred more frequently on deeper productive soils with understory vegetation that provided fine fuels for fire to carry.[132] These low-intensity fires maintained understory species diversity by reducing competition with trees for space and soil nutrients. Since young pinyon and juniper trees (<50 years and up to 4.5 feet in height) are easily killed by fire,[133] establishment of pinyon-juniper was probably limited on such sites and these areas likely existed as juniper savannas.[134] Stands of trees were probably restricted to sites that were rocky or had less productive soils which would not support grasses.[135] Fires on these sites probably occurred infrequently, and were large and high in intensity.[136] These fires would have been more similar to the severe stand-replacing fires that occur in modern pinyon-juniper woodlands.

Since fire frequency is dependent on weather, topography, and soil productivity, return intervals are site specific and vary considerably with location. Historic fire regimes have been reported as being as frequent as 10-30 years[137] and as long as 50-150 years.[138] Historic fire return intervals within the Assessment area are uncertain. However, lower elevation sites with deep soil probably experienced frequent low-intensity fires.

Before European settlement, fire had an important role in some sagebrush steppe community types, increasing the dominance of many herbaceous species while reducing the abundance of woody plants.[139] Presettlement fires are thought to have occurred every 100 to 200 years in low sagebrush community types, and 50 to 100 years in the more arid sagebrush steppe types. However, on more productive sagebrush sites characterized by mountain big sagebrush, fire return intervals have been reported to occur between 12 and 25 years. In southern Utah and northern Arizona, (the Great Basin and Colorado Plateau sagebrush subdivisions), presettlement fire events were less frequent because of limited fuels compared to big sagebrush communities to the north.

Fire severity in big sagebrush communities can be described as 'variable', dependent on fuels, weather, and topography. Site productivity affects the ease with which big sagebrush communities will burn. Highly productive sites with greater plant densities and more biomass are likely to provide more fuel to carry a fire. Among the three subspecies of big sagebrush, basin big sagebrush is considered intermediate in flammability. Mountain big sagebrush is most flammable, and Wyoming big sagebrush is least flammable.[140] Alterations of

[132] Gruell, 1999
[133] Arnold et al., 1964
[134] Johnsen, 1962; Gruell, 1999
[135] Johnsen, 1962
[136] Gruell, 1999
[137] Burkhardt and Tisdale, 1976; Covington and DeBano, 1990
[138] Romme et al., 2001
[139] Miller and Eddleman 2001
[140] Tirmenstein 1999

historic fire regimes have resulted in major successional changes in regions dominated by big sagebrush, and the introduction of exotic annual grasses has modified the role of fire.[141]

Wyoming big sagebrush steppe communities historically had low fuel loadings and were characterized by 10 to 70 year interval, patchy fires that produced a mosaic of burned and unburned lands. In New Mexico, infrequent fire probably maintained Wyoming big sagebrush communities as open, seral stands of Wyoming big sagebrush with productive herbaceous understories. Fire regimes have been radically altered in Wyoming big sagebrush communities heavily infested by cheatgrass. An abundance of cheatgrass enhances the likelihood of fire spread. Fire hazard is estimated to be five times as great in big sagebrush communities converted to cheatgrass. Repeated burning and invasion by cheatgrass removes the mycorrhizael fungi that are associated with sagebrush roots. In cases where sagebrush sites burn two or three times within a ten year period, sagebrush does not regenerate before the next fire cycle and former sagebrush steppes are converted to annual grasslands.[142]

Presettlement fire intervals in mountain big sagebrush communities vary from 15 to 25 years dependent upon geographic location in the intermountain west. Very frequent fire suppresses mountain big sagebrush establishment, while infrequent fire intervals (greater than 20 years) promote tree invasion. In some areas where fire suppression has been a factor, stands of mountain big sagebrush are being invaded by juniper woodlands, lodgepole pine, and Douglas-fir.[143]

Fire intervals in basin big sagebrush are intermediate between mountain big sagebrush (5 to 15 years) and Wyoming big sagebrush (10 to 70 years). Fire in basin big sagebrush communities can typically be described as stand replacing. In many big sagebrush communities, changes in fire occurrence are influenced by fire suppression and livestock grazing activities over time. Many basin big sagebrush sites are now depleted of 'normal' perennial grasses and are now dominated by cheatgrass (*Bromus tectorum*) and other annuals. Annuals increase fuel loads and can set the stage for repeated fires over short time periods. Fire intervals of five years or less do not allow for establishment of big sagebrush seedlings.[144]

Insects and Disease

Where frequent low-intensity fires maintained a landscape with greater spacing between trees, outbreaks of insects such as needle miners were likely limited. Additionally, fires would have limited the spread of diseases such as mistletoe in these sites.

Human Influence

It is important to recognize that plant communities within the Assessment area did not exist in a pristine condition unaltered by humans before European settlers arrived. Prehistoric inhabitants inevitably had an effect on the surrounding landscape and biotic communities. Woodlands throughout the Southwest were extensively utilized, since they occurred at a moderate elevational gradient that provided prehistoric inhabitants with a diversity of plant and animal resources and adequate precipitation for rainfall agriculture.[145]

During the Pueblo Period (approximately 300 BC to 1275 AD), woodlands were heavily occupied by sedentary agriculturalists that lived in extended family groups that probably interacted with one another. These

[141] Johnson 1979
[142] Howard1999
[143] Johnson 1979
[144] Tirmenstein 1999
[145] Cartledge and Propper, 1993

cultures transformed the landscape through activities such as farming, burning, and tree harvesting. Small areas in swales between ridges were burned to make clearings for farming and to enhance soil fertility. Dwellings were located along ridgelines, and trees surrounding these farmsteads were harvested for fuelwood and construction materials. Juniper is believed to have been a particularly important resource, and may have been removed entirely from some sites in the Southwest.[146] Once woodland resources were depleted, inhabitants likely moved on to farm nearby areas. These activities undoubtedly resulted in a much more open landscape than exists in modern pinyon-juniper woodlands.

Agriculturalist occupation of the woodlands ended during approximately 1250-1275 AD. Southern Paiute and probably Navajo hunter-gatherers then began using pinyon-juniper woodlands within the area.[147] Although the Kaibab Paiute continue to use the woodlands in modern times, landscape influences differ between historic use and the period since European settlers limited woodland access. Prior to settlement, Paiutes were nomadic and moved frequently in search of new areas with enhanced forage and game resources. Their primary influence on the woodland landscape was the use of fire for ceremonial purposes and to aid in hunting. Additionally, fire may have been used to encourage plant growth. The Paiute use of fire not only created new openings in the woodlands, but also may have maintained some of the open areas created by earlier cultures.

Adjacent sagebrush desertscrub habitat on the Buckskin Mountains was probably burned for a variety of reasons by Native Americans for hundreds or even thousands of years, but there is no indications of agricultural use of the Buckskin.[148] Pueblo (agricultural) sites are found to the north of the Buckskins in the Vermilion Cliffs area, and to the south on the eastern and western slopes of the Kaibab Plateau. The Buckskin mountain area has archaic (pre-agricultural) and late prehistoric (post-agricultural) sites, but was probably used primarily for hunting and gathering purposes.

[146] Cartledge and Propper, 1993
[147] Fairley, 1989a; Zweifel 2004 (Buckskin Mountain Project Record Document No. 184)
[148] Zweifel 2004 (Buckskin Mountain Project Record document no. 184)

# CHAPTER 4

*CHANGES IN LANDSCAPE CONDITION*

This chapter provides a synthesis of the changes in landscape condition that have occurred within the Assessment area during the last 130 years since European settlement. A discussion of land use practices during the early to mid 1900's is included because these activities differ from the modern practices described in Chapter 2. Additionally, modern landscape conditions are compared to those assumed to have been present in the historic ecosystem in order to assess the impacts of previous activities.

## A. Changes in the Physical Environment

As discussed in previous chapters, processes that act on the physical environment operate on long time scales. Therefore, landforms within the planning area have changed little in appearance since European settlement.

### Air Quality

Changes in air quality have occurred in the region as a result of technological advances over the last century. Emissions delivered by wind from distant metropolitan areas and from vehicles traveling through the Assessment area have undoubtedly decreased air quality. (However, the Assessment area generally has relatively pure air.) Fire suppression activities may also have influenced air quality, but their effects are difficult to determine. Suppressing fire would have reduced smoke at a one point in time, but this may have contributed to conditions that allowed future larger-scale fires with greater emissions.

### Climate

Several minor fluctuations in climate have occurred since European settlement. These variations are worth noting, since they may have influenced patterns of pinyon-juniper distribution and plant community composition within the planning area. The first variation in climate occurred as a moist period from approximately 1890-1920. This period was characterized by years with mild winters and heavier than average summer precipitation.[149] Another climatic variation occurred during the 1950's as a series of extreme droughts. These droughts resulted in massive vegetation die-offs and elevational shifts in plant communities throughout the Southwest.[150]

### Soils

With changes in the ground cover in the area and the increases in human activities (cattle grazing, fuelwood harvesting, road building and associated activities), soil erosion is an increasing concern. In some locations on the Buckskin Mountains, large gullies have formed and evidence of overland flow can be seen.

## B. Changes in the Biological Environment

Considerable changes have occurred in the biological environment since European settlement. Most noticeable is the increase in both size and density of pinyon and juniper trees within the Assessment area. Additionally,

[149] Ffolliott and Gottfried, 2002
[150] Sainsbury, 1995

exotic annuals have invaded many sites and a loss of native understory species is suspected. Finally, shrub species that provide important browse for mule deer may have been over-utilized and appear to be experiencing poor regeneration.

### Pinyon-Juniper Expansion

Pinyon-juniper stands throughout the West have experienced increases in both tree size and density since European settlement, and discussion exists over the degree to which humans have influenced these events and the magnitude at which they are occurring. Similar increases may have occurred in woodlands of the Buckskin Mountains.

As discussed in Chapter 3, historic woodland expansion generally resulted from climate change. In contrast, modern expansion has been attributed primarily to heavy livestock grazing in the early 20th century and disruption of historic fire regimes.[151] Land management policies that encouraged grazing and fire suppression exerted undeniable pressure on woodland ecosystems.

Extensive livestock grazing occurred in the Region during the late 1800's and early 1900's. Grazing was essentially uncontrolled, and had extremely negative impacts on pinyon-juniper woodlands and adjacent shrub-grasslands. Vegetative diversity and herbaceous cover were dramatically reduced, as evidenced by historical accounts of denudation on landscapes that previously supported productive savannas.[152] Removal of herbaceous cover facilitated soil erosion, which then prevented reestablishment of understory plants. Cattle further reduced potential for understory reestablishment by spreading exotic species (i.e., cheatgrass). These dramatic reductions in ground cover decreased resource competition between young trees and herbaceous plants and resulted in a suitable regeneration niche for juniper, pinyon, and other woody species.[153]

Woodland expansion was additionally facilitated by alterations of the historic fire regime. Periodic low intensity fires in shrub and grassland communities within woodlands killed young trees (up to 4.5 feet in height), limiting woodland encroachment and maintaining savanna-like conditions.[154] However, grazing reduced the fine fuels that were necessary to carry such fires, and fire suppression policies further disrupted these processes.[155]

While grazing and fire suppression may have produced a favorable environment for expansion, additional causal factors exist that should not be overlooked. Climatic conditions alone during 1890-1920 favored juniper establishment and vigorous growth.[156] These conditions were likely to promote woodland expansion in both an upward and downward elevational direction regardless of land practices occurring at the time. Arnold et al. found that many juniper trees in woodland stands in northern and central Arizona were established in 1905 and 1919, years that had above average precipitation.[157] During such years, juniper seeds are able to germinate and survive in even the most productive grassland sites. Sainsbury pointed out that the extreme droughts of the 1950's might also have played a role in expansion, because junipers are able to out compete grasses under drought conditions and can rapidly establish on a site where shrubs and grasses have died off.[158] Yet another

[151] Miller and Wigand, 1994; Chambers et al., 1999
[152] Fairly, 1989b
[153] Ffolliott and Gottfried, 2002
[154] Ffolliot and Gottfried, 2002
[155] Pieper and Wittie, 1990
[156] Sainsbury, 1995; Brockway et al., 2002
[157] Arnold et al., 1964
[158] Sainsbury, 1995

causal factor for expansion in some areas may be recovery from prehistoric land use. Sites that had been cleared or harvested by prehistoric inhabitants may simply be experiencing natural tree reestablishment.[159]

Discussion also exists as to the magnitude of woodland expansion. Pinyon-juniper expansion has popularly been viewed as a massive invasion of trees into areas historically occupied by shrubs and grasslands. This is contradicted by current research, which suggests that the observed increases in area occupied by woodlands may be attributed to a more moderate "fill in" of the canopy in stands that existed prior to settlement, rather than an explosion of tree establishment.[160]

While the causes and magnitude of woodland expansion are debatable, the effects on vegetation and abiotic components of a system are well documented. In general, expansion at a site results in increased soil erosion, altered nutrient cycles, decreased seed reserves, reduced understory production, and overall decreases in plant species diversity.[161] Effects on wildlife have received limited attention and are poorly understood. Arnold et al. suggested that since junipers suppress growth of some understory grasses and forbs, expansion has reduced the amount of palatable forage for many wildlife species.[162] Expansion has been found to decrease habitat quality and increase predation risk for pronghorn[163] and ground-nesting birds.[164]

**Native Understory Degradation**

While reconstructing historical information on the composition and distribution of grasses and forbs is difficult, the use of paleoecological evidence and historic documents indicates that a diversity of understory plants would have been found in the region. It appears from our vegetation results that the understory components of both the woodland and sagebrush portions of the Buckskin Mountains have been degraded. Understory species of grasses and forbs are limited in species diversity and densities. Some portions of the area are almost completely lacking in understory, aiding in the erosion of topsoil, and further degradation of the area.

**Exotic Species Invasion**

Exotic plant species were introduced to the area by cattle during the late 1800's and early 1900's. These species have gained dominance in understory plant communities in many areas. Exotics are able to gain dominance in these communities because they possess a variety of strategies to out compete native plants. Strategies include early germination and establishment,[165] high fecundity, efficient dispersal mechanisms, reduced palatability to animals, and chemical inhibition of other plants.[166]

Exotic species invasion of native plant communities is problematic for several reasons. Since invasive exotics typically become dominant in a community, the overall result is a loss of diversity in the understory.[167] This loss in plant diversity generally translates to a loss of wildlife habitat. Invasion by exotic species is additionally problematic, since accelerated erosion may occur in areas dominated by exotic annuals. These annuals have shallow fibrous roots or taproots that are less effective in stabilizing soil than the deep-spreading root systems

[159] Cartledge and Propper, 1993; Romme et al., 2001
[160] Shaw, 1999; Ffolliot and Gottfriend, 2002
[161] Bunting et al., 1999
[162] Arnold et al. 1964
[163] Ockenfels et al., 1994
[164] Rosenstock, 1999
[165] Beckstead et al., 1995
[166] Covington et al., 1994; Monsen, 1994
[167] Covington et al., 1994

of native perennial grasses. Further, exotic annual grasses, such as cheatgrass, burn more readily than native grasses and have altered fire cycles in many plant communities.

Cheatgrass density and distribution has increased significantly in pinyon-juniper communities throughout the West.[168] It has invaded areas once dominated by woody species such as sagebrush, shadscale, winterfat, and saltbush; and in some areas cheatgrass exists as nearly pure stands that are devoid of any native understory species. Cheatgrass has been successful at gaining dominance over native plants in these communities, since it exhibits earlier and more rapid growth.[169] Additionally, cheatgrass has altered grassland fire regimes in such a way that conditions perpetuate invasion.[170] Cheatgrass provides highly flammable tinder that results in more rapid spread of fire than is common in native bunchgrass ecosystems. It also tends to shorten fire return intervals because it provides a source of fuel every year. Further, wildfire facilitates cheatgrass establishment yet eliminates many native range species.

Many sites within the planning area have experienced cheatgrass invasion and alteration of the fire regime. Invasion by cheatgrass is particularly problematic on sites that have experienced heavy grazing or wildfire. These sites have also been invaded by other exotics such as Russian knapweed (*Centaurea repens*), bindweed (*Convolvulus arvensis*), Scotch thistle (*Onopordum acanthium*), and Johnson grass (*Sorhgum halepense*). Other annual weed species that may contribute to increased fire risk or which displace more edible forbs or grasses in disturbed sites of Buckskin Mountain include musk-mustard (*Chorispora tenella*), storksbill (*Erodium cicutarium*), bur buttercup (*Ranunculus testiculatus*), and tumbling mustard *(Sisymbrium altissimum*). Horehound (*Marrubium vulgare*), a mostly inedible perennial weed, has become well established throughout sagebrush-dominated areas of the Buckskin where it has replaced edible forbs. Tamarisk (*Tamarix chinensis*) has become established in a few areas.

**Lack of Shrub Regeneration**

In addition to the changes that have been observed in the overstory and herbaceous understory of the area, changes have occurred in the shrub component as well. Shrubs including cliffrose, big sagebrush, bitterbrush, four-wing saltbush, green ephedra *(Ephedra viridis)*, mountain mahogany, oak, and winterfat *(Krascheninnikovia lanata)* provide important browse for mule deer. These species have been impacted by overuse and have generally shown poor regeneration throughout the area. Shrubs that generally do not resprout well following fire, such as cliffrose and sagebrush, have been impacted by wildfire. In contrast, fire-sprouting species (e.g., oak and mountain mahogany) may be experiencing poor regeneration in areas due to a lack of frequent low-intensity fire.

The condition of cliffrose in the planning area is particularly problematic. It is a highly palatable browse species that may have been extensively overused when mule deer populations erupted in the region during the 1920's and 1930's. Some recovery has occurred, but many plants exist in a decadent condition and no longer provide adequate forage. Vegetation data collection for the Buckskin area appears to show that cliffrose is a limited resource in the area, and browse plants in general are in predominantly decadent condition.

[168] Monsen, 1994
[169] Beckstead et al., 1995
[170] Monsen, 1994

## C. Synthesis of Change

Considerable changes have occurred in the biological environment within the planning area since European settlement. Some changes, such as pinyon-juniper expansion may have occurred despite human activities. However, it is likely that human interference with ecological processes has facilitated increases in expansion rate and area of occurrence. Other changes (e.g., loss of understory cover and exotic plant species invasion) are likely the result of management practices during the late 1800's and early 1900's.

Sites that have experienced changes due to past management practices generally exist as degraded woodland or desertscrub communities. These sites could benefit greatly from management activities aimed at enhancing the native understory, controlling exotic species, reducing soil erosion, and improving shrub regeneration.

# CHAPTER 5

*WILDLIFE NEEDS*

Wildlife species depend on their surroundings to provide the basic resources and environmental conditions that are necessary for them to survive and successfully reproduce. These resources and conditions are collectively referred to as habitat. In general, there are four basic components of habitat: food, water, cover, and space. Each species of wildlife has its own set of requirements related to these components.

Degraded plant communities within the planning area may not meet the habitat requirements of some wildlife species. This chapter provides a discussion of the needs of several focal species or assemblages of wildlife and offers suggestions for how management activities might alter the environment to better meet their needs. It is assumed that management activities designed to benefit these species will have positive effects on other species with similar habitat requirements.

## A. Grassland Birds

Grassland breeding birds (e.g., horned larks and meadowlarks) need adequate grass cover for nesting and adequate shrub cover for nesting and singing perches.[171] Pinyon and juniper have expanded into sagebrush-grassland sites within the Assessment area and reduced the size of habitat patches with adequate cover for these species. Sites that have experienced tree expansion are further unsuitable for grassland birds because of increases in nest predation facilitated by greater availability of habitat for predators. Habitat for grassland breeding birds in the planning area could be improved through management activities aimed at reducing or removing juniper in sites historically occupied by grassland vegetation.

## B. Merriam's Turkey

Merriam's turkeys forage in pinyon-juniper woodlands during winter, and are especially dependent on pinyon pine and Gambel's oak trees as sources of mast (fruits or nuts of woody plants). Since turkeys also depend on ponderosa pine as a mast source, and as roosting and loafing habitat, stringers (non-contiguous linear patches) of ponderosa pine and Gambel's oak that run through drainages or down hillsides into pinyon-juniper stands provide particularly valuable habitat.[172] Further, Wakeling and Rogers found that small openings ($\leq$.03 ha) in higher elevation pinyon-juniper stands near ponderosa pine were especially important as feeding and roosting habitat during harsh winters.[173]

Management activities aimed at stimulating growth of Gambel's oak and pinyon and at creating small openings in woodlands adjacent to ponderosa pine could increase foraging opportunities and provide higher quality roosting and loafing habitat. The addition of new water developments and repair of existing water sources in these areas could further improve turkey habitat.

[171] Rosenstock, 1999
[172] D. Wright, personal communications
[173] Wakeling and Rogers, 1995

C. Sage grouse

Sage grouse populations are tied closely with sagebrush habitats, but are also depended on healthy grass and forb communities within the sagebrush for nesting and brood rearing. While no sage grouse are currently known within the Buckskin area, they probably used the area historically, and during pre-settlement times.

Management activities aimed at increasing the diversity of forbs, increasing perennial herbaceous cover heights, and creating openings in sagebrush canopies could increase foraging opportunities and provide higher quality habitat.[174]

D. Bats

Sagebrush-grassland ecotones provide important foraging opportunities for many bat species within the Assessment area. Management activities that open tree canopies along woodland edges are likely to benefit these bats by increasing the amount of foraging habitat that is available.

Bats may limit their use of otherwise suitable habitat because of a lack of water availability.[175] Therefore, surface water is a critical component of bat habitat in arid habitats. Large areas of surface water are particularly important to large bat species that lack maneuverability and have difficulty obtaining water from small sources. Because surface water attracts many insects, it is further valuable as foraging habitat. All bat species within the area would benefit from accessible surface water. Modification of existing waters to make them more accessible to bats would facilitate this.

E. Mule Deer

Woodland provide important migratory and winter range for mule deer. Habitat used during migration consists of higher elevation ecotonal areas where Gambel's oak and ponderosa pine intermingle with pinyon and juniper.[176] Winter range typically includes sagebrush-grasslands, juniper savannas, and pinyon-juniper woodlands with a large shrub component.

Food appears to be the limiting factor for mule deer populations on both migratory and winter ranges.[177] During fall migration acorns and green basal foliage of perennial grasses provide nutritious forage. In winter, cliffrose and sagebrush are particularly important as browse, and cool season grasses provide an additional food source.

Mule deer may further benefit from management activities in other woodland areas. Activities aimed at facilitating growth of Gambel's oak in woodlands could improve the quality of migratory range. Those designed to reduce tree densities, create small openings in dense stands, or control tree expansion into adjacent sagebrush-grasslands could provide additional winter foraging opportunities.

The addition of new water developments along migratory routes or in areas that are heavily used but lack surface water would further enhance mule deer habitat. Limited existing developments can cause deer and cattle to focus on existing waters, creating a situation of heavy use and competition for resources that will inevitably reduce range condition. This is particularly problematic in critical portions of the winter range. In

[174] Connelly et al. 2000
[175] Chung-MacCoubrey, 1996
[176] McCulloch and Smith, 1991
[177] McCulloch and Smith, 1991

addition, greater benefits may be derived from maintaining existing water developments to hold water year-round, instead of only when cattle are using the area.

**Relationship of Seasonal Energy Demands to Mule Deer Habitat Use**[178]

Mule deer energy intake during the summer is 4.0 times higher than in winter, and it is estimated that during summer foraging bouts, energy intake is 2.5 times greater than the energy invested.[179] Winter energy intake is only 0.7 times the energy expended; therefore the higher energy accumulations in the summer are critical for building energy reserves and are directly related to winter survival.

In winter, forage quality declines and food availability is reduced. Increasing snow accumulations in addition to making food inaccessible, limits physical movement and increases energy costs. Thus, survival of individual mule deer ultimately depends on maintaining a positive energy balance. Adequate thermal cover may serve to reduce individual mule deer energy demands during low availability and quality of forage. Because the Kaibab and Paunsaugunt mule deer herds are migratory, their seasonal environments must provide cover suitable for maintaining positive energy balance under a wide range of climatic conditions. Thus, management that emphasizes providing short-term food resources, most often winter forage, may mask the role of topography and cover in providing important thermo-regulation niches.

Even in these migratory herds, the increased costs of maintaining normal body functions during periods of extreme weather and reduced forage can put animals into a negative energy balance for four or more months a year. This increases the importance of maintaining high-quality winter ranges that provide adequate foraging and thermo-regulation resources.

Messmer stated that, based on their studies, forage availability for both mule deer and domestic livestock has been significantly reduced on this winter range largely because of encroachment of pinyon-juniper, heavy common use by livestock on preferred mule deer microhabitats, and lack of cliffrose rejuvenation.[180] In addition, the forage available on most of the winter range also may be nutritionally deficient. In response to this habitat condition, the deer are utilizing some habitats more frequently. As well, foraging on alternate plant species increases as the availability of preferred food items decreases. In some cases these alternate foods may have increased toxins, such as terpenes and alkaloids. Thus, the deer appear to be searching out plant species that provide them with macronutrients, which allow them to increase their intake of these toxic forage items. Similarly, animals eating foods high in protein tend to search out other food sources that provide them with larger amounts of energy so that they can process the high protein matter.

Messmer's study also stated that water accessibility did not appear to influence Buckskin mule deer home range use patterns. However, during periods of below normal precipitation, mule deer movements appeared to be closely tied to more permanent water sources. These observations suggest that during extended drought periods, water availability could affect mule deer movements and winter range habitat use.

Messmer described that bedding areas were typically found in association with pinyon pine or juniper tree canopies. These sites exhibited reduced wind speeds, a litter understory, large patches of bare soil, reduced amount so snow accumulation, and were typically located on southeast facing slopes. Two microhabitat components that proved to be important at feeding sites were weather conditions and the presence of cliffrose.

[178] Buckskin Mountain Project Record document No. 162
[179] Messmer, 2000
[180] Messmer, 2000

Buckskin mule deer appear to increase their foraging activity when temperatures were moderate and when no precipitation was occurring. Foraging activities were suspended when temperatures dropped or during inclement weather. During these periods they used areas that afforded adequate thermal cover.

Cliffrose was an important winter forage resource for the Buckskin mule deer herds. More cliffrose occurred on sites where mule deer were observed feeding than bedding. Livestock also were observed foraging on cliffrose. Deer bedding and feeding sites were commonly used by livestock. This suggests that livestock and mule deer are competing for these limited resources.

F. Pronghorn

Moderate encroachment of pinyon-juniper woodlands on sagebrush-grasslands has reduced the amount of available habitat for pronghorn within the area. Pronghorn avoid closed pinyon-juniper stands because they offer limited foraging opportunities and prevent the long sighting distances that are required to avoid predators.[181] Closed stands may restrict pronghorn movements and inhibit use of adjacent grassland habitat. Conversely, pronghorn have been found to use isolated juniper trees for thermal cover, and may use open woodlands if visibility is adequate for them to detect predators. Pronghorn habitat could be improved through management activities designed to reduce juniper tree densities and stimulate understory growth in areas historically occupied by grassland vegetation.

Habitat could be further improved by structural modification of sagebrush at these sites. Big sagebrush provides pronghorn with important forage during winter, and in spring provides bed sites for fawns.[182] While pronghorn require adequate cover for these activities, they avoid overly dense stands.[183] Dense stands camouflage predators and fail to provide high quality forage because they typically consist of decadent plants with reduced nutritional value. Management activities designed to create a mosaic of age classes in even-aged patches of sagebrush would benefit pronghorn in the planning area.

The addition of new reliable water developments would greatly improve conditions for pronghorn within the planning area. In particular, pronghorn survival could be improved by developments located in areas with potential for quality fawn bedding habitat.[184]

[181] Ockenfels et al., 1994; Bright and Van Riper, 2001
[182] Bright and Van Riper, 2001
[183] Ockenfels et al., 1994
[184] Dorothy Ticer and Miller, 1994

# CHAPTER 6

*DESIRED LANDSCAPE CONDITION*

The desired condition for the Buckskin Mountain Assessment area is based on landscape conditions thought to be present prior to European settlement, as identified in Chapter 3. Note that it will not be possible to return the landscape to historic conditions, nor will it be desirable on some sites. Instead, proposed management activities are intended to move the landscape towards a state of improved ecosystem health and function. This chapter identifies conditions that are the desired outcome of such activities.

A. Desired Condition of the Physical Environment

**Air Quality**

It is desired that air within the Assessment area remain of high quality. However, brief and occasional periods of reduced air quality are anticipated when wildfire, wildland fire use, and prescribed fire use occur within the region.

**Watershed Function and Soils**

It is desired that watershed function be improved within the planning area through reductions in soil erosion. Erosion should be reduced through increases in ground cover brought about by improved herbaceous understory production across the planning area. Improved soil stabilization should reduce gully formation and bank cutting. Although undesirable, some soil movement is anticipated on steep slopes during high-intensity precipitation events.

B. Desired Condition of the Biological Environment

**Vegetation**

Within the sagebrush desertscrub communities in the Assessment area it is desired that there be a broad range of conditions (e.g., from sites with high sagebrush densities to those that are more open than at present). Overall, it is desired that there be increased native plant species diversity. Sagebrush should exist in a mosaic of age classes. Native grasses and forbs should be abundant in the understory. There should be a diversity of native shrubs in a mosaic of age classes.

It is desired that lower-elevation pinyon-juniper woodlands within the Assessment area resemble a savanna with a mosaic of large-diameter trees, few small trees, abundant native grasses and forbs, and a diversity of native shrubs. Stands of shrubs should display a mosaic of age classes.

Within interior woodlands, it is desired that there be a broad range of conditions (e.g., from sites with high tree densities to those that are more open than at present). Overall, it is desired that there be increased native plant species diversity. However, pinyon pine and Gambel's oak should not be reduced. Trees should exist in a mosaic of sizes. Native grasses and forbs should be abundant in the understory. There should be a diversity of native shrubs in a mosaic of age classes. Browse shrubs should be abundant and should exist in growth forms that are accessible to mule deer.

It is desired that there be fewer sites within the planning area infested with noxious and invasive weeds. Patch size of cheatgrass and other invasive species should be reduced, and spread of weeds to uninfested sites should be controlled.

It is desired that Sensitive, Threatened, and Endangered plant species be protected and maintained in understory communities throughout the planning area.

**Wildlife**

It is desired that woodland and desertscrub habitat be improved for the many species of wildlife in the Assessment area. Overall, foraging opportunities and cover availability should be increased through improved herbaceous production and structural diversity.

It is desired that habitat be improved for grassland breeding songbirds. Increased production of grasses and shrubs where savanna-like conditions have been restored to lower-elevation sites should provide improved cover for nesting and a greater number of singing perches.

It is desired that habitat be improved for Merriam's turkeys, where appropriate. Greater numbers of small openings in higher elevation woodlands adjacent to ponderosa pine and near pine-oak stringers should increase availability of foraging sites. Additionally, foraging opportunities in these areas should increase through improved regeneration of Gambel's oak and pinyon pine.

It is desired that habitat be improved for bats. A greater number of openings in grassland-sagebrush ecotonal areas along woodland edges should increase foraging opportunities.

It is desired that habitat be improved for mule deer. Small openings in pinyon-juniper woodlands and reductions in tree densities should increase foraging opportunities through improved regeneration of browse species and greater production of understory grasses and forbs. Scattered patches of dense trees in woodland stands should continue to provide adequate thermal cover and adequate cover to shield movements.

It is desired that habitat be improved for pronghorn. Increased production of grasses and a greater diversity of age classes in sagebrush stands where savanna-like conditions have been restored should provide improved opportunities for foraging and bedding. Reductions in juniper tree densities along woodland edges should facilitate movements between habitat patches.

It is desired that the wildlife species discussed above be abundant within the planning area. Sensitive, Threatened and Endangered wildlife should be present as well.

**Disturbance**

It is desired that naturally occurring periodic fires be restored to lower elevation sites within the planning area to maintain juniper-savanna conditions. These low-intensity fires should encourage a diverse understory of native shrubs, grasses and forbs; and should not cause more than 50% mortality of pinyon, juniper, and Gambel's oak trees. Large-scale high-intensity fires that occur within interior woodland stands in the planning area should continue to be suppressed.

It is desired that the potential for epidemic outbreaks of insects and other disease be reduced within the planning area. However, insects and disease organisms should remain present at endemic levels.

It is desired that grazing be excluded from treated sites within the planning area for a period of 2 to 4 growing seasons to allow site recovery. Grazing should continue to be carefully managed in untreated locations to move habitat toward recovery.

**Resources**

It is desired that pinyon-juniper woodlands within the planning area continue to provide fuelwood-harvesting opportunities, and sources for pinyon nut gathering and harvesting of medicinal plants. Additionally, it is desired that woodlands continue to provide high-quality hunting and recreational opportunities.

The desired Buckskin Fuelwood Area Boundary is to change the cutting area boundary to a boundary that can be easily explained to the public, and easily patrolled by Law Enforcement Rangers.[185] Note that this would entail an amendment to the current Monument Management Plan[186]. The suggested boundary would follow Highway 89 from approximately milepost 45 (GSENM ROUTE 715) to approximately milepost 37 (Kaibab Gulch). From here the proposed boundary would follow the Kaibab Gulch to GSENM Route 700 (House Rock Valley Road). The proposed boundary would then follow GSENM Route 700 south to the Arizona/Utah State Line. The proposed boundary would follow the state line west until the GSENM boundary. From there the proposed boundary would go north following the GSENM boundary up to GSENM Route 715, and then continue to Highway 89.

It is desired that as much access to pinyon-juniper woodlands be maintained as possible. However, unmaintained social trails should be closed in areas where restoration activities are taking place to prevent degradation and allow site recovery.

It is desired that users of the woodlands display behavior consistent with "leave-no-trace" ethics. Users should not leave trash, or drive off-road or on roads that have been closed for site recovery.

[185] Buckskin Mountain Project Record Document No. 14
[186] USDI 1999, pg 28, FP-1 and FP-2.

# CHAPTER 7

*RECOMMENDATIONS FOR HABITAT IMPROVEMENT*

This chapter provides recommendations for management activities that can be undertaken to improve wildlife habitat within the planning area. These activities are intended to move the landscape toward the desired conditions identified in Chapter 6.

## A. General Recommendation for the Buckskin

**Improve herbaceous understory production through seeding where necessary.**

Seeding may be necessary to improve native herbaceous understory conditions at disturbed sites where seed sources are lacking. Such sites may include those grazed by cattle during spring, those with heavy cheatgrass infestation, and those that have been burned by wildfire. Note that cheatgrass infested sites and sites burned by wildfire should be carefully surveyed to determine the potential for natural recolonization by native plants. Seeding may be avoided if native seed sources are present in the seedbank or within 300 feet.[187]

Seeding may be unnecessary on treated sites because understory species will be released from competition for space and nutrients. Soil samples can be used to confirm seedbank potential in treated areas.

On sites where seeding is necessary, an experimental approach should be used. By conducting seeding trials, appropriate methods can be determined and the information gained will add to the body of scientific knowledge. Treatments should be designed to investigate various seeding methods, techniques to cover seed, and techniques to prevent seed predation by rodents and insects. Seeds should be collected on-site from native plants. When on-site collection is not possible and seeds have to be purchased, they must be certified to be free from noxious weeds. Complex seed mixtures of grasses, shrubs, and forbs will provide the most benefit for wildlife.

**Retain slash in treated areas to facilitate understory recovery.**

Slash produced by tree or sagebrush removal should be retained and scattered into interspaces and across drainages. Scattered slash will facilitate understory recovery because it provides a favorable microclimate for herbaceous establishment and protection against grazing herbivores.[188] Additionally, it will decrease the potential for soil erosion by reducing the amount of bare ground.[189] Further, slash will provide cover for some wildlife species.[190]

Note that excessive amounts of slash may cause problems for wildlife. This is particularly true for pronghorn, which require long sighting distances to avoid predators.[191] Slash of up to 2 feet (approx. 0.6 meters) in height may be tolerated by pronghorn if it is scattered loosely enough to prevent visual obstruction.[192] For other

[187] Reading 2002
[188] Arnold et al., 1964
[189] Wilcox, 1994; Jacobs and Gatewood, 1999
[190] Neff et al., 1979; Severon, 1986; Severson and Rinne, 1990
[191] Ockenfels et al., 1994
[192] Reading 2002

wildlife species, leave no more than 20% slash cover in treated openings.[193] Excess slash may be reduced by methods such as crushing or chipping, or through off-site disposal. Slash should not be burned on-site, since this may negatively affect soil nutrients and site productivity.[194]

**Improve browse species regeneration in stands that are decadent, impacted, or heavily used.**

Attempts to improve browse species regeneration will be necessary to maintain mule deer populations within the area. Efforts will be necessary to rejuvenate stands of decadent shrubs (e.g., cliffrose and big sagebrush), to improve recruitment in stands burned by wildfire, and to facilitate establishment in sites treated to reduce densities.

Because browse species are genetically diverse, the success of regeneration efforts is generally site specific. Therefore, research may be necessary about the genetics, ecology, and reproductive biology of browse species within the planning area to determine which techniques are appropriate. Additionally, experimental trials may be necessary for evaluating the usefulness of various techniques.

Prescribed fire is not recommended as a tool for improving browse species regeneration since most shrubs within the area are weak or non-sprouting species that are likely to be damaged by fire and slow to recover.[195] Further loss of production by these species could have serious consequences for the deer herd.

Priority should be given to improving browse regeneration in critical winter range and areas of winter range that receive the heaviest use. Deer within the planning area are limited by food availability in these areas.[196] South- and west-facing slopes receive the most sunlight and accumulate the least snow; therefore they receive high levels of use.[197] Browse treatments may be most beneficial on these slopes and in areas adjacent to reliable water sources.

For pronghorn, focus should be given to improving regeneration in known feeding sites located less than one mile (1.6 km) from a reliable water source.[198] Treatments aimed at rejuvenating decadent stands of big sagebrush should be designed to reduce shrub densities to between 5% and 30% ground cover.[199] However, rubber rabbitbrush should be protected and enhanced because it is a highly preferred browse species. Note that in order to provide for bird species diversity and raptor habitat, no more than 30% of large sagebrush patches should be treated in a given area.[200]

**Control spread of cheatgrass and other noxious and invasive weeds within the planning area.**

Control of cheatgrass and other noxious and invasive weeds should be attempted at heavily infested sites within the area because these sites are likely to be too degraded to experience natural recovery within an acceptable time period.[201] Additionally, these sites provide sources for noxious and invasive weeds to disperse into other areas. Control efforts are likely to be effective only in small patches, which will require repeated treatments and diligent monitoring.

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[193] Payne and Bryant, 1994: 301
[194] Covington and DeBano, 1990
[195] Ferguson, 1983; Severson and Rinne, 1990
[196] Haywood et al., 1987
[197] Carpenter and Wallmo, 1981
[198] Ockenfels et al., 1994
[199] Yoakum, 1983
[200] Payne and Bryant, 1994:297
[201] Monsen, 1994

Areas that are experiencing only mild cheatgrass invasion may be able to recover naturally through recolonization by native species. A landscape change analysis would be useful to determine rate of spread of cheatgrass in these areas before control efforts are initiated.

**Protect treated areas to facilitate site recovery.**

All treated sites area should be protected to facilitate recovery of native plant communities. Unmaintained roads should be closed to reduce erosion potential and spread of noxious and invasive weeds. Grazing should be excluded for an adequate time period to allow native understory establishment and vigor. Livestock exclusion period required to allow full establishment of seeded native species and recovery of surviving native plants may be more than two years.[202] Site evaluation will be required to determine when native seedings should be grazed again.

**Reduce effects of erosion events**

In areas that have developed large gullies, efforts should be made to reduce further degradation of the area. Increasing groundcover, whether through increased vegetation cover or through retention of slash have beneficial effect. Other more serious methods to reduce overland flow may be needed in some areas.

B. Woodland

**Thin juniper to reduce competition for understory grasses, forbs and shrubs. Increase wildlife forage and structural heterogeneity.**

Juniper trees should be thinned in interior woodland stands (i.e., those occurring away from woodland edges and ecotonal areas) to improve foraging opportunities for mule deer and other wildlife species, and to increase structural heterogeneity. Thinning releases browse and herbaceous plants from competition for water and soil nutrients, thus facilitating production and increasing availability of forage. As plants increase in the mid-story and understory, structural habitat becomes more diverse. This increase in structural heterogeneity translates directly to increased habitat availability for many wildlife species.

Thinning of pinyon pine and Gambel's oak is not recommended because these species are of high value to wildlife as forage. Precautions should be taken to protect these species during treatment. It is particularly important to protect pinyon, since they appear to be a limited feature in the landscape and drought-related mortality is a concern.

Juniper trees should be thinned to densities similar to those that existed at the time of European settlement (approximately 1870), in order to mitigate the effects of recent human-caused disturbances and interruption of the natural disturbance regime. The goal of approximating historic stand densities is to produce woodlands that are more diverse and are more resilient to disturbance than those that currently exist within the planning area. Historic stand densities can be simulated by removing the majority of trees that established after settlement (note that adequate numbers of young trees must be retained to provide for recruitment). The Ecological Restoration Institute at Northern Arizona University has suggested that both pinyon and juniper trees greater than 20 inches (50.8 centimeters) diameter at root collar (DRC) are likely to have been established prior to European settlement in the region. This estimate is based on regional dendrochronology, and is intended to be

[202] USDI 1999:pg26 RM-3

conservative.[203] However, additional dendrochronology may be necessary to determine site-specific conditions within the planning area.

Treatments should focus on sites where levels of deer use are greatest. In general, south- and west-facing slopes receive the most use during winter.[204] Among high-use sites, priority should be given to stands with deeper more productive soils because the potential for understory recovery is greatest in these areas. Dense clumps of trees should be left in treated stands to provide for hiding and thermal cover, and to facilitate movement. Additionally, known bedding sites and travelways should be protected and cover should be left intact. Snags should be retained within treated stands to provide habitat for cavity-nesting species. Treatments should be conducted during late summer and early fall to reduce impacts to non-game species.[205]

**Create small openings in woodlands to increase foraging opportunities, and encourage habitat diversity.**

Small openings should be created in dense interior stands to increase foraging opportunities for mule deer and other wildlife. Small openings allow increased production of forage plants because competition with trees for space and nutrients is reduced. Large-scale clearings should be avoided because mule deer require adequate tree cover to meet thermal demands in winter.[206] Fairchild suggested that opening design should reflect the importance of thermal cover over the need for foraging areas.[207] Because Neff et al. and Fairchild considered thermal requirements of mule deer in designing open areas, the following recommendations are provided from their work. [208] Openings should be created only in stands that are more than 0.5 miles (0.8 km) wide, with greater than 20% canopy cover, and more than 12 trees per acre (30 trees/hectare). Openings should be between 100 and 660 feet (approx. 30-200 meters) in width. (Areas less than 100 feet may be too small to allow recovery of understory growth because of exclusion due to juniper allelopathy. Those greater than 660 feet would be too large to provide adequate cover for mule deer and are likely to be avoided.) Openings should follow natural physical boundaries and assume irregular shapes with feathered edges. Long thin openings may be most beneficial.[209] Openings should total less than 1/3 of the area of winter habitat. Untreated areas 300 feet (approx. 90 meters) in width should be left between openings, and should be arranged as travel corridors. Naturally sparse stands and scattered thickets of trees provide preferred winter habitat and should be left unmanaged. Areas with known bedding sites should be avoided. Additionally, stringers of riparian vegetation and ponderosa pine should be avoided. Openings should be created near water sources, but away from centers of human activity such as highways and recreational areas. Finally, they should be created using cutting methods that will not impact shrubs that provide important browse.

Because removing trees may decrease habitat for wildlife that forage or nest in the canopy, old-growth trees and snags should be left in openings to retain important habitat features. Additionally, scattered clumps of trees should be left throughout open areas to provide habitat diversity and facilitate wildlife movement. Fairchild recommended spacing these clumps approximately 300 feet apart.[210]

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[203] D. Huffman, personal communication. Buckskin Mountain Assessment Project Record document No. 11
[204] Carpenter and Wallmo, 1981
[205] O'Meara et al., 1981 as reviewed by Payne and Bryant, 1994: 299
[206] Carpenter and Wallmo, 1981
[207] Fairchild, 1999
[208] Neff et al., 1979; Fairchild, 1999
[209] Suminski, 1993
[210] Fairchild, 1999

**Create small openings to increase foraging opportunities for Merriam's turkeys.**

Additional small openings should be created at sites in higher elevation woodlands to increase suitable winter feeding habitat for Merriam's turkeys. These sites should be adjacent to ponderosa pine and should have Gambel's oak and pinyon pine present. Openings should be no larger than 0.03 hectares to insure that adequate cover is provided.[211] Openings created near water and in close proximity to known roosts will convey the most benefit.

C. Savannah

**Control woodland expansion and restore savanna-like conditions to lower-elevation sites within the planning area.**

Post-settlement juniper trees (<20 inches DRC[212]) should be removed along woodland edges to restore savanna-like conditions in sites that were historically occupied by grassland vegetation. Cutting methods should be chosen so that impacts to soils and existing understory plants are minimized. Efforts should be focused in areas with a well-established perennial grass component, since the potential for understory recovery will be greatest in these sites. Treatments should be designed to enhance habitat for pronghorn and grassland birds.

Reductions to 2 trees per acre could provide high quality habitat for pronghorn.[213] Note that single trees should be left in flat open areas to provide thermal cover. Treatments are likely to be most beneficial in known feeding sites or where movement between patches of high quality foraging habitat is restricted. Treatments will be most effective for maintaining pronghorn numbers when located less than 1 mile from a reliable water source.[214] Additional treatments (e.g., reducing sagebrush or rejuvenating decadent stands) may be required to further improve forage availability at these sites.

To improve habitat for grassland birds, treatments should reduce juniper densities to fewer than 4 trees per acre.[215] Treatments should be designed to retain shrubs, such as four-wing saltbush and Fremont barberry (*Berberis fremontii)*, in order to provide song perches and nesting cover.

The effectiveness of woodland control projects will inevitably be reduced by birds dispersing pinyon seeds and juniper berries.[216] Therefore, treatments may need to be repeated in order to prevent pinyon-juniper expansion into areas where grassland vegetation has established.

**Avoid using prescribed fire to remove juniper and restore savanna-like conditions until some recovery of the native understory has occurred.**

Prescribed fire should be avoided as a tool for tree removal and restoration of savanna-like conditions in lower-elevation sites until the herbaceous understory experiences some recovery. The high temperatures required to burn large trees in removal efforts are likely to result in reduced recovery potential because of soil sterilization (a loss of soil nutrients and microorganisms).[217] Further, past management practices have resulted in degraded

[211] Wakeling and Rogers, 1995
[212] D. Huffman, personal communication. Buckskin Mountain Project Record document No. 11
[213] Alexanders and Ockenfels, 1994
[214] Ockenfels et al., 1994
[215] Rosenstock, 1999
[216] Balda, 1986
[217] Covington and DeBano, 1990

woodlands that are unlikely to respond to prescribed fire in the same way as historic savanna communities because a threshold has been crossed in ecosystem function.[218] Immediately reintroducing fire in a degraded understory community may result in additional deterioration from losses in soil nutrients,[219] and increases in noxious and invasive annuals.[220]

Because fire played an important role in maintaining historic savanna conditions, the ultimate goal is to return this process to lower-elevation woodland sites. Once some recovery of the native understory has taken place, prescribed fire could be used to maintain the desired savanna-like conditions. In this event, it will be necessary to determine the fire history of these sites. (See Chapter 3 for a discussion of the wide range of variability in historic woodland fire regimes.)

Note that fire should not be introduced to woodland stands that are surrounded by cliffs, slickrock, or other barriers that may have served to prevent fire spread in the past. Frequent fire regimes are unlikely to have occurred in these stands.[221] Instead, they probably experienced infrequent (e.g., hundreds of years) stand replacing wildfires.

D. Desertscrub

**Reduce sagebrush cover to improve understory grasses and forbs. Increase wildlife forage and structural heterogeneity.**

Sagebrush should be thinned in decadent stands (i.e., those that are composed primarily of dense mature to decadent sagebrush plants; little to no understory present) to improve foraging opportunities for wildlife species, and to increase structural heterogeneity and native plant species diversity. Reductions in sagebrush cover releases herbaceous plants from competition for water and soil nutrients, thus facilitating production and increasing availability of forage. As plants increase in the mid-story and understory, structural habitat becomes more diverse. This increase in structural heterogeneity translates directly to increased habitat availability for many wildlife species.

Sagebrush should be thinned to densities of 15-25% cover, to encourage forb and grass growth.[222] The goal of these sagebrush stand densities is to produce sagebrush desertscrub that are more diverse and are more resilient to disturbance than those that currently exist within the area. By reducing the density of sagebrush, and increasing the grass and forb component, desertscrub habitat may again be suitable for use by Sage grouse.

Treatments goals should focus on restoring habitat characteristics favorable for sage grouse. Manage Wyoming sagebrush (potential breeding) habitats to support 15-25% canopy cover of sagebrush, perennial herbaceous cover averaging $\geq$7 inches (18cm) in height with $\geq$15% canopy cover for grasses and $\geq$10% for forbs and a diversity of forbs during spring.[223] Create a mosaic of openings in mountain sagebrush and mixed-shrub communities (potential summer habitat) where total shrub cover is $\geq$35%. Generally, 10-20% canopy cover of sagebrush and $\leq$25% total shrub cover will provide adequate habitat for sage grouse during

[218] Tausch, 1999
[219] Covington and DeBano, 1990
[220] Monsen, 1994; Overby et al., 2000
[221] Romme et al., 2001
[222] Connelly et al. 2000
[223] Connelly et al. 2000; pg 977

summer.[224] Treatments should be conducted during late summer and early fall to reduce impacts to non-game species.[225]

**Remove all post-settlement juniper trees from woodland expansion areas to restore sagebrush community in lower-elevation sites.**

Post-settlement juniper trees (<20 inches DRC[226]) should be removed from areas that are determined to be historically sagebrush desertscrub habitat. Historic sagebrush desertscrub habitat can be defined as those areas that are dominated by mature sagebrush; areas with deep soils below 6000 feet in elevation. Cutting methods should be chosen so that impacts to soils and existing understory plants are minimized. Efforts should be focused in areas with a well-established understory component, since the potential for understory recovery will be greatest in these sites. Treatments should be designed to enhance habitat for sage grouse and other sagebrush dependent birds.

Reductions to 2 trees per acre could provide high quality habitat for pronghorn.[227] See Savannah recommendations above for more details on Pronghorn habitat needs.

To improve habitat for sagebrush birds, treatments should reduce juniper densities to fewer than 4 trees per acre.[228] Treatments should be designed to retain shrubs, such as four-wing saltbush and Fremont barberry (*Berberis fremontii)*, in order to provide song perches and nesting cover.

The effectiveness of woodland control projects will inevitably be reduced by birds dispersing pinyon seeds and juniper berries.[229] Therefore, treatments may need to be repeated in order to prevent pinyon-juniper expansion into areas where sagebrush vegetation has established.

[224] Connelly et al. 2000: pg 980
[225] O'Meara et al., 1981 as reviewed by Payne and Bryant, 1994: 299
[226] D. Huffman, personal communication. Buckskin Mountain Project Record document No. 11
[227] Alexanders and Ockenfels, 1994
[228] Rosenstock, 1999
[229] Balda, 1986

# CHAPTER 8

*TECHNIQUES TO ACHIEVE HABITAT IMPROVEMENTS*

This chapter identifies techniques that may be used to improve wildlife habitat. These techniques are based on current scientific knowledge and have been applied in pinyon-juniper woodlands and sagebrush desertscrub, similar to those of the Buckskin Mountains area. See Appendices G and H for further discussions and field trip notes on treatment methods and results. Selection of appropriate treatment methods will to be highly site dependent, so no recommendations are made at this time.

## E. Techniques for Reducing Tree Densities

Many techniques are available for reducing pinyon and juniper tree densities within the planning area. Selective cutting methods may be used to create small openings or reduce tree densities in interior stands. Clearing methods are available for controlling expansion along woodland edges.

### Hand Thinning

Trees may be selectively removed from treatment areas by hand thinning with chainsaws, handsaws, or other hand tools. Hand thinning allows for creation of exact landscape patterns because individual trees or clumps of trees can be left standing. This method is highly desirable because it is a very thorough means of tree removal yet has minimal impacts to soils and understory vegetation.[230] However, it may be more costly than other methods because it is labor intensive. Possible options for reducing cost include conducting treatments as fuelwood sales or using volunteer or prison labor.

Hand thinning is appropriate for treating sensitive areas where mechanical methods are unacceptable.[231] Additionally, it is highly effective in treatments aimed at creating specific landscape patterns (e.g., restoration treatments designed to simulate historic stand conditions). Hand thinning is a useful method for removing small young trees from previously treated sites. However, it is not an appropriate method for clearing trees from large areas because of the high cost of treatment.

### Mechanical Removal

Several mechanical methods are available for removing trees within the planning area. These methods have traditionally been used to convert large areas of woodlands to grassland in order to improve forage for livestock. However, they have also been used on a smaller scale to improve habitat for big game by clearing trees in small patches.

Trees can be cleared from an area by chaining, cabling, roller chopping, and pushing methods. Chaining and cabling methods are accomplished by dragging a heavy chain or large steel cable across a stand between two tractors.[232] Roller chopping is accomplished by dragging a steel drum with cutting blades across an area. Pushing involves using a bulldozer or tractor to uproot individual trees. Chaining and cabling methods are effective in removing large trees from an area, but are generally considered inefficient as clearing methods

[230] Evans, 1988
[231] Evans, 1988
[232] Evans, 1988

because small trees are missed and additional treatments are required for their removal. These methods cannot be used to selectively thin a stand. Roller chopping is more efficient and can be used somewhat selectively because machinery is more maneuverable. However, young pliable trees are still missed and require other means of removal. Pushing is the most efficient mechanical clearing method because trees of all sizes can be removed.[233] Additionally, it can be used selectively since individual trees can be targeted. Pushing is twice as costly as chaining and cabling methods. However, this cost is offset by the higher degree of effectiveness. Chaining, cabling, roller drum chopping, and pushing methods severely impact soils and understory vegetation. Therefore, these methods are inappropriate for use in the planning area.

An alternative method for mechanically removing trees is to use cutting blades attached to a small bobcat (hydro-axe). This method is advantageous, since it can be used to selectively thin juniper trees up to 12 inches diameter at root crown and has less impact on soils and understory plants than other mechanical means. However, it cannot be used on areas with boulders or on steep slopes, and site impacts are still greater than hand thinning. The small bobcat may not be an appropriate cutting method in interior stands with a large number of desirable shrubs because they may be damaged inadvertently. Instead, this method may be efficient for removing trees along woodland edges where expansion is occurring. Many of the latter sites contain decadent stands of sagebrush that must also be reduced or treated, and impacts to brush will not be adverse in these areas.

Another alternative method for mechanically removing trees is to use an environmental brush cutter (Bullhog) attached to a rubber-tired tractor.[234] The brush cutter is considered to be a time saver and allows the removal of vegetation in one operation. Less traffic for the project sites results in less compaction of soil. The machine will reduce trees and shrubs quickly to ground level, not disturbing root material. The material is shredded into a mulch that should rapidly biodegrade. With the material left in place it reduces erosion and keeps nutrients in the soil, increasing its fertility. It also cannot be used on areas with steep slopes, and impacts are still greater than hand thinning. Similar problems with damage to desirable shrubs could occur in dense stands.

**Prescribed Burning**

Fire is an efficient method for removing pinyon and juniper trees because small trees (<4.5 feet) are easily killed and effects are long lasting.[235] However, using fire in pinyon-juniper woodlands is problematic and can have undesirable results. Because high-intensity fires are required to kill large trees, burns must be conducted under extreme conditions.[236] This makes treatment boundaries difficult to control and presents a potential for wildfire. An additional problem resulting from high-intensity fire is soil scorching. This negatively affects a site's potential for recovery because it reduces seed sources and eliminates microorganisms that facilitate growth of understory vegetation.[237] Further, the growth of exotic annual cheatgrass is perpetuated by fire and burning may encourage cheatgrass invasion in treated areas.[238] Under this scenario, vegetative succession is set back to an early-seral stage of annual and noxious weeds, in which many years are required before a conversion to native grassland is possible.

[233] Evans, 1988
[234] Buckskin Mountain Project Record documents No. 101 and 148
[235] Arnold, et al., 1964
[236] Evans, 1988
[237] Covington and DeBano, 1990
[238] Monsen, 1994

### Chemical Control

Individual pinyon and juniper trees within the area can be killed chemically by the herbicides picloram and tebuthiuron.[239] These herbicides work through the soil and are degraded by microorganisms, sunlight, and growing plants. Hazards to animals, people, and the environment are reported to be minimal if the label directions are followed.

These herbicides are an efficient and economical means for controlling saplings or young trees in areas that are experiencing woodland expansion or in areas where mechanical treatments were previously applied.[240] They can also be used on steep sloped sites because they do not affect soil stability. However, their use is limited in projects designed to enhance understory production because they often damage non-target plants. The establishment of cool season grasses, desirable forbs, and sensitive plants may be delayed on sites treated with tebuthiuron for several years.

## F. Techniques for Reducing Sagebrush Densities

### Mechanical Removal

Several mechanical methods can be used to reduce sagebrush canopy. A brush beater is essentially a mowing attachment for a tractor.[241] It can be set a various heights to determine the amount of sagebrush cover that is removed. Height should be set no lower than 10 inches if you want young sagebrush to be maintained at the site (See Appendix H, Stop 4 vs. Stop 8)

The Lawson (meadow) aerator, although not designed specifically for treating sagebrush, has shown promise in rejuvenating sagebrush stands.[242] It tends to eliminate larger, older, decadent plants while limiting harm to younger plants. It may also leave protective litter in place and create little soil disturbance. Preliminary data collected on a research project at Deseret Land and Livestock in a decadent stand of Wyoming big sagebrush in Rich County, Utah, indicates that density was reduced by 45%.

The rangeland drill combines soil disturbance (creating a seed bed) with a seeding mechanism.[243] Its main purpose is to put seed into the ground; however the disks will also crush sagebrush. Depth regulator bands are mounted on the discs to regulate the depth the seed is being sown. Units can be equipped with separate seed boxes allowing grasses, forbs and shrubs to be seeded at one time. This method causes more soil disturbance than the other methods described above. A drill disturbs 80% of the soil surface, cutting into the soil surface 2-3" with side casts of 4" of soil.[244]

The Pipe (Dixie) Harrow has several large, heavy metal bars with 10" flanges that are dragged behind a tractor. Sagebrush plants are crushed, and some are dragged. The degree of disturbance can be adjusted by adding or removing bars. This method is good for preparing a seed bed because it disturbs more soil than other methods, however the increased disturbance can also lead to increased exotics and erosion.[245]

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[239] Evans, 1988
[240] Evans, 1988
[241] http://www.wildlife.utah.gov/gbrc/brushbeater.html; Buckskin Mountain Project Record document No. 187
[242] http://www.wildlife.utah.gov/gbrc/lawsonaerator.htm; Buckskin Mountain Project Record document No. 187
[243] http://www.wildlife.utah.gov/gbrc/rangelanddrill.htm; Buckskin Mountain Project Record document No. 187
[244] See Appendix G: pg 2-3
[245] See Appendix H

Chaining is a highly controversial methods of treatment, but may be a very good tool in sagebrush. Monsen describes chaining, when done right, as a much better tool than disking, drill seeding, etc., with less soil disturbance.[246] You can adjust amount of cover removal to as little as 20% depending on how the chain is used, the type of chain, and the number of swivels. Chaining does not influence the understory in sagebrush.

**Chemical Control**

Similar to chemical methods described for woodland, individual sagebrush within area can be killed chemically by the herbicides such as tebuthiuron.[247] These herbicides work through the soil and are degraded by microorganisms, sunlight, and growing plants. Hazards to animals, people, and the environment are reported to be minimal if the label directions are followed.

These herbicides are an efficient and economical means for controlling sagebrush in areas that are experiencing canopy increases, but have an intact seed source of grasses, forbs and shrubs. They can also be used on steep sloped sites because they do not affect soil stability. However, their use is limited in projects designed to enhance understory production because they often damage non-target plants. The establishment of cool season grasses, desirable forbs, and sensitive plants may be delayed on sites treated with tebuthiuron for several years.

G. Techniques for Treating Slash

Several options exist for treating slash, the trees and unwanted stems and branches that result from tree and shrub removal. Slash may be left on-site and treated by lopping and scattering. It may be disposed of on-site by burning, or removed and disposed off-site.

**Lopping and Scattering**

Slash may be left on-site, lopped into smaller pieces, and scattered into interspaces between trees and across drainages where it will gradually decay. Scattering slash in this manner provides several important benefits. First, scattered slash provides ground cover that will reduce soil movement.[248] In rapidly eroding areas at Bandelier National Monument, soil loss was reduced 2 orders of magnitude on sites where slash was lopped and scattered.[249] Additionally, scattered slash encourages understory regeneration. The slash creates a favorable microclimate (e.g., rich in nutrients and high in soil moisture) for plant establishment and provides protection from grazing herbivores.[250] Finally, leaving slash on-site may benefit some wildlife species. Scattered slash provides security areas for deer and escape cover for small mammals.[251] However, it may cause a detrimental visual obstruction for pronghorn. A further disadvantage of leaving slash on-site is the temporary fire hazard it presents. This hazard is reduced after the first year, however, because needles drop from the branches and flammability decreases.[252]

Lopping and scattering slash is appropriate on sites where trees have been thinned or on sites where trees have been cleared from light to moderately dense stands. Sites where trees have been cleared from pronghorn habitat or from dense stands with large amounts of slash may require additional methods to reduce accumulations.

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[246] See Appendix G; pg 2-3, and others
[247] See Appendix H, Stop 6 and Stop 11
[248] Evans, 1988; Wilcox, 1994; Jacobs and Gatewood, 1999
[249] Hastings et al., 2001
[250] Arnold et al., 1964
[251] Severson and Rinne, 1990
[252] Evams. 1988

### Burning

Slash may be disposed of on-site by burning. However, this practice is not recommended because of the potential for impacts to soil. Burning heavy accumulations of slash often causes high soil heating, which may result in reduced site recovery. Overby et al. found that burning slash on a pinyon-juniper site in central Arizona caused almost 50% of the soil to be exposed to erosion and unpalatable noxious and invasive plants to increase.[253] Covington and DeBano reported that sites where slash piles were burned near Flagstaff remained devoid of vegetation after more than 20 years.[254]

If slash must be burned, it should not be piled. Instead, it should be broadcast into interspaces between trees to reduce soil heating.[255] Burning should be conducted during cool moist conditions as a further precaution.

### Off-site Disposal

As an alternative means of disposal, heavy accumulations of slash may be moved off-site. For example, tree trunks can be cut and stacked along roadsides for firewood, while smaller material can be burned at another location or disposed of in a local landfill. Off-site disposal may be more costly than burning slash on-site, but is advantageous because impacts to soil are greatly reduced.

## H. Techniques for Increasing Herbaceous Understory Production

The most popular methods for enhancing understory plant production include slash treatment, seeding, and prescribed burning. Each of these methods has been used with varying degrees of success, and results are typically site-specific. However, general recommendations exist for their application.

### Slash Treatment

As discussed in the previous section, slash may be scattered into interspaces between trees to facilitate plant establishment, discourage herbivory, and reduce soil erosion. This technique is cost-effective and efficient and has been used successfully on a variety of woodland sites throughout the West. Loftin reported significant increases in herbaceous plant abundance and species richness after only 2 growing seasons on unseeded sites where slash had been scattered.[256] Jacobs and Gatewood experienced similar success with 2- to 7- fold increases in total herbaceous cover on unseeded sites with slash treatments.[257] Interestingly, sites that were seeded did not yield greater herbaceous production. Neither author reported the depth at which slash was scattered on treated sites.

### Seeding

Seeding may be required if a site does not have sufficient seed sources to promote understory recovery or to exclude exotic weeds that would otherwise dominate the area.[258] Seedbanks are typically deficient in sites where wildfire has caused soil scorching that eliminated seed sources, in overgrazed sites, and in sites where invasion by exotics is problematic.

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[253] Overby et al. 2000
[254] Covington and DeBano 1990
[255] Covington and DeBano, 1990
[256] Loftin, 1999
[257] Jacobs and Gatewood, 1999
[258] Campbell, 1999

Seeding Methods

Seeding may be accomplished through direct seeding (sowing seed into the soil) or broadcast seeding (scattering seed over the soil surface) methods. The most popular means for direct seeding are drilling and imprinting. In drilling, rows of small furrows are made in soil by a rangeland drill, which then drops seed and covers it. In imprinting, large seed is broadcast in front of a heavy roller, which then presses seed firmly into the soil; small seed is usually broadcast into the depressions behind it. Direct seeding is advantageous, as it provides hydraulic contact of the seed with the soil for germination and successful growth.[259] Additionally, sown seeds are less subject to desiccation and predation than broadcast seeds. However, direct seeding is more costly. Because drilling and imprinting involve heavy machinery, they negatively impact soils and existing vegetation, and can only be used on level areas that are free from obstacles. Therefore, these methods are inappropriate on culturally sensitive sites, sites with important understory species, and sites with steep or rocky terrain.

Seed may be broadcast over small sites using hand-held equipment or over larger areas using spreaders mounted on vehicles. Additionally, seed may be aerially broadcast over very large or inaccessible areas by aircraft. The major advantages of broadcast seeding are that is quick, relatively inexpensive, and low in impact to soils and existing plants.[260] However, it is generally less effective than direct seeding because exposed seed is subject to desiccation and predation. Increasing seeding rate can compensate for seed loss. Additionally, planting success can be improved by covering broadcast seed. Seed can be covered with soil by dragging chain or pipe across the treated site, or with materials such as scattered slash, mulch, or straw. The latter methods are more appropriate on sensitive sites because they can be done by hand with less impact to soils and existing vegetation.

Interseeding

Existing understory communities can be supplemented through interseeding. Interseeding is most commonly achieved through direct seeding methods in which seeds are sown in strips that have been cleared in established vegetation. Broadcast seeding is usually considered an inefficient interseeding method because of competition from established plants.

Interseeding is most appropriate on sites with severely depleted understories, and where erosion hazards are high.[261] It is most effective for planting cool-season species into existing warm-season vegetation where sufficient fall and early spring moisture will provide planted species with a competitive advantage.

Seed Species

Mixed seedings of native and exotic species have been used in many revegetation projects. Exotics often germinate earlier and at faster rates and are intended to provide herbaceous cover until natives can take hold. Unfortunately, these mixed seedings often result in exotic monocultures that support little diversity and are susceptible to insect damage and other problems.[262] Exotics may reduce establishment of native shrubs and forbs included in the seed mix and may limit natural reproduction of established shrubs. Many exotics have adversely impacted the natural functioning of plant communities.[263] Further, exotics can be unpalatable to

[259] Evans, 1988
[260] Evans, 1988
[261] Whisenant, 1999: 210
[262] Roundy et al., 1997
[263] Campbell, 1999

wildlife because they often have less nutritional value than native forage. For example, crested wheatgrass is unpalatable to pronghorn and may not be consumed, even on sites where it is the dominant species.[264]

There are some situations where the use of exotic species may be appropriate. For example, when site conditions are so altered that native species are no longer able to establish and persist, exotics may be the only option for establishing ground cover. However, when management goals are to enhance the herbaceous understory and restore community function, the use of exotics will confound revegetation efforts. Therefore, exotic mixtures should be avoided and only native species should be selected for seeding. Complex mixtures of native grasses, forbs, and shrubs are most beneficial for achieving wildlife habitat improvement objectives.

Wildland plants exhibit a wide range a genetic diversity, and little is understood about the genetics, reproductive biology, and ecology of many species. Therefore, collecting seed on-site is likely the only way to insure that plants are adapted to local conditions.[265] Although on-site seed collection is desirable, it is labor intensive and may not be feasible. In this event, seed should be purchased from a reliable native seed supplier. Seed should come from a source that is as close as possible to the project site and must be certified to be free from noxious weed seeds.

### Time of Planting

Because germination and seedling establishment require ample soil moisture and favorable temperatures, seeding is most effective just prior to the longest period of favorable growing conditions.[266] Where most of the precipitation occurs as winter snow, the primary growing season occurs during early spring. Cool-season species are generally best seeded in fall in these regions, while warm-season species are best seeded in late winter to mid-spring.

### Mulching

Straw mulch is generally assumed to be beneficial in revegetation efforts on arid and semi-arid lands. However, Chong found that straw mulch did not enhance seedling establishment.[267] Belnap and Sharpe reported that 50% cover by straw mulch from native grasses actually reduced seedling survival.[268] They hypothesized that straw mulch holds moisture above the soil, which may cause seedlings to grow shallow roots along the surface that are inadequate for anchoring. Both authors concluded that straw mulch was costly and ineffective in revegetation efforts. Scattered or chipped slash that is left on-site can act as mulch, with less cost and greater benefit.

### Seeding Establishment

Finally, seeded areas should be protected from grazing for several growing seasons to insure herbaceous community establishment.[269] Sites that have been seeded with species that develop relatively quickly should be protected for at least 2 growing seasons. Those that have been seeded with slow-developing species may require up to 4 growing seasons of non-use.

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[264] Yoakum, 1983
[265] Roundy et al., 1997
[266] Whisenant, 1999: 200
[267] Chong, 1993
[268] Belnap and Sharpe, 1994
[269] Stevens, 1986

### Prescribed Burning

The affects of prescribed burning on understory production are related to site characteristics such as community composition before burning, soil depth and condition, canopy closure, and fire history. In general, prescribed fire applied to open stands on deep productive soils typically results in rapid recovery of understory communities and enhanced herbaceous growth.[270] Prescribed fire applied to closed stands on shallow soils in poor condition typically results in slow recovery of the understory with development dominated by exotic annuals. Therefore, prescribed fire may have positive effects in lower elevation sites in the planning area with deeper soils, but is likely to be inappropriate in interior stands.

## I. Techniques for Controlling Cheatgrass and Other Noxious and Invasive Weeds

Controlling noxious and invasive weeds is necessary to reduce competition and facilitate establishment of native seedlings, as well as to improve functioning of the understory community.[271] Control measures should be aimed at eliminating live plants, preventing seed formation, and controlling seed germination and establishment.

### Eliminating Live Plants

Live plants may be eliminated by hand pulling or mowing, and by using herbicides. Hand pulling or mowing may be feasible in small patches, but are impractical on large sites. On large sites the use of herbicides will be advantageous. Several herbicides are available for controlling cheatgrass invasion. These include Assure II™ (quizalofop), Gramaxone™ (paraquat), Plateau™ (imidazolinone), Roundup™ (glyphosate), and Oust™ (sulfometuron methyl). These herbicides are highly effective at controlling cheatgrass, but may also damage desirable vegetation. Assure II™ may suppress seedhead production of perennial grasses. Roundup™ is a non-selective herbicide that will damage or kill native forbs and woody plants if contact occurs.

### Preventing Weed Seed Formation and Controlling Weed Emergence

Measures such as tilling and burning may be effective in controlling seed dispersal and plant emergence. For example, cheatgrass can be controlled by spring tillage or burning mature plants before seed dispersal, followed by fall tillage to remove emergent plants.[272] (Note that burning can reduce cheatgrass densities, but may actually result in cheatgrass spread due to higher seed production the following year. Thus, burning must be followed by additional treatments to remove seedlings.)

Seeding native species is another effective method for controlling the spread of emergent weed seedlings. Floyd-Hanna et al. reported that aerial seeding of native species was effective at reducing musk thistle invasion in pinyon-juniper sites that were burned by wildfire at Mesa Verde National Park.[273] Late fall to early winter seeding of native grasses has been successful in reducing cheatgrass infestation, because native grasses grow rapidly at low temperatures and are capable of competing with cheatgrass seedlings.[274] Squirreltail has been particularly effective in out competing cheatgrass when seeded in early fall.[275]

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[270] Erskine and Goodrich, 1999
[271] Monsen and McArther, 1995
[272] Monsen, 1994
[273] Floyd-Hanna et al., 2001
[274] Monsen, 1994
[275] Beckstead et al., 1995

Seeding may be unnecessary if natives are naturally recolonizing an infested area. In a long-term study of grassland sites invaded by cheatgrass, Hosten and West found that native species gradually reestablished in understory communities.[276] Similar cases of natural reestablishment have been reported throughout the West.[277]

On seeded sites or sites where natural recolonization is occurring, disturbance should be minimized to facilitate establishment of the native community.[278] This may require closing roads, excluding grazing for several growing seasons, and limiting ground-disturbing activities in neighboring areas.

## J. Techniques for Improving Browse Species Regeneration

When natural regeneration of browse species, such as cliffrose and big sagebrush, is insufficient to meet wildlife needs it may be desirable to use artificial regeneration techniques. Available techniques include seeding, transplanting, and inducing disturbance.

### Seeding

Seeded rosaceous shrubs (e.g., cliffrose and bitterbrush) generally do not establish well because of competition by herbaceous plants.[279] For this reason, broadcast seeding is rarely successful, especially when seeds are sown in a mixture with grasses and forbs. Direct seeding in fall is most effective for these species. Suminski reported success in planting cliffrose by direct seeding with a small drill, but suggested that hand planting scarified seed in small caches may also work well.[280] Wetted carbonate polymer crystals can be added in hand plantings to aid seedling establishment. This inert material holds water within its walls and releases it only when the plant root draws it out; hence, it can provide a moisture source during dry conditions.

Broadcast seeding is usually effective for small-seeded species such as big sagebrush and winterfat.[281] Late fall to early winter is the best period for seeding big sagebrush because this is the time that seeds would naturally be dispersing. (Broadcasting seed on snow has been very successful during this period.) Because sagebrush seedlings require nurse plants, it may be advantageous to first establish early-seral species (e.g., squirreltail) on a site before seeding.

In general, shrubs in pinyon-juniper communities exhibit a large degree of genetic variation, and many species readily hybridize. While this creates a special need for conservation of genetic diversity, it has also allowed for development of accessions that are adapted to particular environmental conditions. Accessions are available for big sagebrush, winterfat, cliffrose, and bitterbrush species. These provide managers with good choices; however, the most successful plantings still result from seeds collected on-site.[282] When on-site collection is feasible, seeds should be from the same subspecies of shrub and should be obtained from an adjacent wildland area with similar habitat characteristics.

[276] Holsten and West, 1994
[277] Monsen, 1994
[278] Monsen, 1994
[279] Ferguson, 1983
[280] Suminski, 1993
[281] Meyer, 1994
[282] Roundy et al., 1997

### Transplanting

Transplanting has several advantages over seeding in shrub establishment. First, transplants are less susceptible to damage than seedlings.[283] They are able to compete better with adjacent vegetation, and usually grow larger than seeded plants after the first couple of years. Additionally, they can be placed at desired locations in controlled densities. The major disadvantage of using transplants is that this method is expensive and labor intensive.

Rosaceous shrubs can be established from bare-root stock planted in early spring.[284] However, container grown transplants may be more reliable because they are less susceptible to shock after planting and are better able to tolerate competition and harsh environments. True mountain mahogany can be propagated from cuttings, but cliffrose, bitterbrush, curlleaf mountain mahogany, and Utah serviceberry do not root well. Planting transplants in small basins (approximately 30 cm in diameter) that provide catchments for rainfall can increase chances for survival.

Big sagebrush can be effectively established from transplants. However, broadcast seeding is generally successful and is a more efficient and cost-effective method.

Once transplanted shrubs have established, they must be protected from excessive use. In general, no more than 40% of the current year's growth can be taken for shrubs to survive.[285] To ensure survival, deer and cattle should be excluded from treated areas for 2 to 4 years following establishment.

### Disturbance Treatments

Decadent stands of shrubs can be rejuvenated through disturbance treatments such as pushing, thinning, and burning. These treatments can be used to alter growth characteristics of older shrubs so that they become more available as browse, or to facilitate establishment of younger shrubs by reducing densities of older plants.

Older cliffrose shrubs often become arboreal and are unavailable as browse because leaders grow far above deer reach. To alter growth habits, plants may be pushed over and torn apart. Hand pushing is recommended, since only older decadent plants should be targeted. This method stimulates leader growth along branches that lie on the ground, making shrubs more accessible as browse. Suminski reported that leader growth was still taking place in pushed and torn plants 2 years after treatment.[286]

Decadent stands of big sagebrush can be rejuvenated through mechanical treatments. These treatments are used to thin stands so that new shrubs can become established, or to create openings for the growth of herbaceous species. Popular mechanical methods include chaining, plowing, and crushing or chopping treatments. Crushing or chopping methods are generally preferred because they have the least impact on soils and cause little damage to herbaceous plants.[287]

Prescribed fire has been used as a tool to rejuvenate fire-sprouting browse species such as oak and mountain mahogany. However, its use is not recommended for big sagebrush, bitterbrush, or cliffrose. Burning can

[283] Whisenant, 1999: 217
[284] Ferguson, 1983
[285] Suminski, 1993
[286] Suminski, 1993
[287] Payne and Bryant, 1994: 297

nearly eliminate these species, since they do not resprout well;[288] and range recovery can take 15 years or longer.[289]

**Other Issues with Browse Establishment**

Specific recommendations are not provided for rejuvenating species such as four-wing saltbush, winterfat, and green ephedra. Information is lacking about the abilities of these species to establish by seeding and transplanting methods and little is known about their response to regeneration treatments. Interseeding might be useful in attempting to increase establishment of these plants.

For all browse species to be seeded, seeds should be collected on-site if possible. When this is not feasible, use accessions that are well adapted to site conditions. The USDA Natural Resources Conservation Service has developed a list of accessions that have been approved for revegetation projects.[290]

Finally, all treated stands should be protected from herbivory for a period of 2 to 4 years. Efforts to improve regeneration may be wasted if browse pressure is not eliminated for a sufficient time period to insure the continued growth and survival of established plants.

## K. Techniques for Wildlife Friendly Wildlife Water Developments

Water developments on public lands are designed to meet the needs of livestock, wild horses and wildlife. To reduce the risk of wildlife fatalities, the BLM has required installation of escape ramps in water developments for many years.[291] Note that water developments that require escape ramps are troughs, open spring boxes, open tanks, and guzzlers. This does not include dirt tanks, pit reservoirs, naturally occurring waters, or closed tanks not accessible to wildlife.[292] Escape ramps have not always been constructed of the most durable materials (i.e. boards, and logs), and do not always stay within water developments. All water developments within the Buckskin Mountain area should be equipped with metal escape ramps securely attached to the outside edge of a water development, and should reach to the bottom of the structure to facilitate escape from the water development no matter what level of water is inside the development.

In addition, wildlife developments should be evaluated for other hazards to wildlife such as wire and fence post that may cause hazards. Since water developments are designed to meet the needs of wildlife as well as livestock, existing developments should provide water year round, not just when livestock are present.

[288] Ferguson, 1983; Severson and Rinne, 1990; Suminski, 1993
[289] Suminski, 1993
[290] Available at: http://Plant-Materials.nrcs.usda.gov
[291] BLM Manual Handbook H-1741-2 Water Developments 11/06/1990
[292] BLM Instruction Memorandum No. 2004-156. See Buckskin Mountain Project Record Document No. 188. Available Online: http://www.blm.gov/nhp/efoia/wo/fy04/im2004-156.htm

# CHAPTER 9

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# CHAPTER 10

*TABLES*

**Table 1. Grazing Allotments within the Buckskin Mountain Assessment area.**

| *Allotment* | *Pasture* | | *ACRES* |
|---|---|---|---|
| Coyote-AZ | | TOTAL | 6,241.7 |
| Mollies Nipple | Buckskin | | 23,833.1 |
| | Private | | 160.4 |
| | | TOTAL | 23,993.5 |
| Sink Holes | | TOTAL | 4,336.3 |
| Rock Reservoir | | | 1,131.4 |
| | | | 5.8 |
| | | TOTAL | 1,137.2 |
| Vermilion | Private | | 14.5 |
| | Government Reservoir | | 2,841.8 |
| | Paria Road | | 390.6 |
| | Fossil Wash | | 2,049.7 |
| | | TOTAL | 5,296.6 |
| Grand Total | | | 41,005.3 |

**Table 2. Grazing Allotment use within the Buckskin Mountain Assessment area.**

| *Allotment* | *Season of Use* | *Permitee* | *Managed by* | *Usual Numbers* | *AUMs* |
|---|---|---|---|---|---|
| Coyote-AZ (aka Pine Hollow)[293] | Year round | O.I. & Dixie Northcott | Arizona Strip BLM | 34 cattle | 286 Active, 244 Suspended |
| Mollies Nipple[294] | Nov-April | Calvin & Que Johnson | Monument | 377 cows | 628Active |
| Rock Reservoir[295] | Nov-May | Dale & Mark Spencer | Arizona Strip BLM | 4 cattle[296] | 22 Active, 9 Suspended |
| Sink Holes | Nov-March | Charlie Heaton | Monument | 18 cows | 154 Active |
| Vermilion[297] | Nov-April | Norm & Worth Brown | Monument | 280 cows | 780 Active |

[293] Pers. Comm., Robert Sandberg, 9/03/2004.

[294] Pers. Comm., Allan Bate 10/07/2004. Estimate for Buckskin Pasture portion of Mollies Nipple Allotment.

[295] Pers. Comm., Robert Sandberg, 9/03/2004.

[296] Is run in conjunction with Franks Allotment which has 48 cattle for the same period. At any given time there could be 52 cattle on Franks or Rock Reservoir (Bob Sandberg, pers. Comm.. 9/03/2004).

[297] Pers. Comm.. Allan Bate 10/07/2004. Estimate for Government Reservoir, Fossil Wash and Paria Road Pastures

**Table 3. Characteristics for soil map units found on the Buckskin Mountain Assessment area.**

| *Map Unit* | *Area*[298] *(acre)* | *Wind Erosion*[299] | *Slope (%)* | *Depth (in)* | *Skeletal*[300] | *Water Erosion* | *Available Water* | *Calcium Carbonate (%)* | *Gypsum (%)* |
|---|---|---|---|---|---|---|---|---|---|
| 5037 | 93.0 | Low | 2-10 | 60 | 85% no | Mod | Moderate | 30 | 0 |
| 5125 | 868.9 | Low | 2-15 | 60 | 85% yes | Low | Low | 30 | 0 |
| 5158 | 7879.6 | High-mod | 25-60 | 0-12 | 45% yes 40%RO[301] | Low | 45%Very low 40%RO | 30 | 0 |
| 5159 | 8792.8 | 60%low 20%mod | 2-30 | 10-21 | 60% yes 20% no | Low | Very low | 15-30 | 0 |
| 5160 | 16328.9 | 60%low 30%mod | 2-15 | 13-33 | 45% yes 45% no | Low | Very low – low | 0-2 | 0 |
| 5163 | 850.5 | Mod | 2-8 | 19-65 | 35% yes 55% no | Low | Low-very low | 15-30 | 0 |
| 5166 | 527.8 | 55%low 30%mod | 2-30 | 4-24 | 55% yes 30% no | 55%low 30%mod | Very low | 15 | 0 |
| 5170 | 342.1 | Mod | 2-20 | 15-49 | 90% no | 30%mod 60%high | Low- very low | 14-30 | 90 |
| 5171 | 2341.3 | Mod | 2-30 | 11-29 | 90% no | 35%mod 55%high | Low-very low | 15-30 | 0-90 |
| 5172 | 2178.6 | Mod | 2-8 | 60-61 | 95% no | Low | Moderate-high | 15 | 0-4 |
| 5173 | 927.6 | 70%mod 20%low | 2-20 | 8-60 | 35%yes 70%no | Mod | Very low-low | 5-30 | 0 |

[298] Map units less than 26 acres were not included in this table.
[299] Wind and water erosion data is derived from the surface layer of the soil profile.
[300] Greater than 35% coarse fragments (rocks) in the soil profile.
[301] Rock outcrop

**Table 4. Big Sagebrush Characteristics by sub-species.**

| | *A.t.ssp.wyomingensis* | *A.t.ssp. tridentata* | *A.t.ssp.vaseyana* |
|---|---|---|---|
| Common name | Wyoming big sagebrush | basin big sagebrush | mountain big sagebrush |
| Moisture requirements | Most xeric (20-32 cm) | intermediate | most mesic (31-149cm) |
| Landscape Position | Lower: valley bottoms, plains | Intermediate: hill slopes, benches, etc | Higher: shoulder slopes, mountain slopes |
| Plant height | Shortest (< 0.5m) | Tallest (> 1.5m) | Intermediate |
| Inflorescence | Throughout crown | Throughout crown | Upper crown – flat top |

**Table 5. Average percent use for browse species on the Buckskin Mountains by site type.**

| *Pinyon-Juniper* | | *Sagebrush* | |
|---|---|---|---|
| **Species** | **Ave % Use** | **Species** | **Ave % Use** |
| *Artemisia nova* | 22.7 | *Krascheninnikovia lanata* | 95.0 |
| *Purshia tridentate* | 19.3 | *Purshia stansburyianna* | 17.2 |
| *Artemisia tridentate* | 12.6 | *Artemisia tridentate* | 7.6 |
| *Purshia stansburyianna* | 10.6 | *Quercus gambelii* | 2.5 |
| *Quercus gambelii* | 6.3 | | |
| *Amalanchier utahensis* | 2.5 | | |

**Table 6. Recent fires within the Buckskin Mountain area.**

| *Fire No.* | *Name* | *Year* | *Month* | *Location* | *Approx. Acres* |
|---|---|---|---|---|---|
| R363 | Buckskin | 1998 | July | T43S2W Sect 6 | 1110 |
| R361 | Eagle Eye | 1998 | July | T43S R3W Sec 22 | 0.1 |
| R353 | No Pine Hollow | 1998 | July | T43S R3W Sec 22 | 41 |
| R353 | No Pine Hollow | 1998 | July | T43S R3W Sec 22 | 41 |
| R266 | Buckskin | 1997 | July | T43S R02W Sec 6 | 355 |
| -- | Buckskin | 1996 | -- | T43S R3W Sec14 | 300 |

# CHAPTER 11

*FIGURES*

**Fig. 1. Tree density by size class for Pinyon-Juniper Sites on the Buckskin Mountain area.**

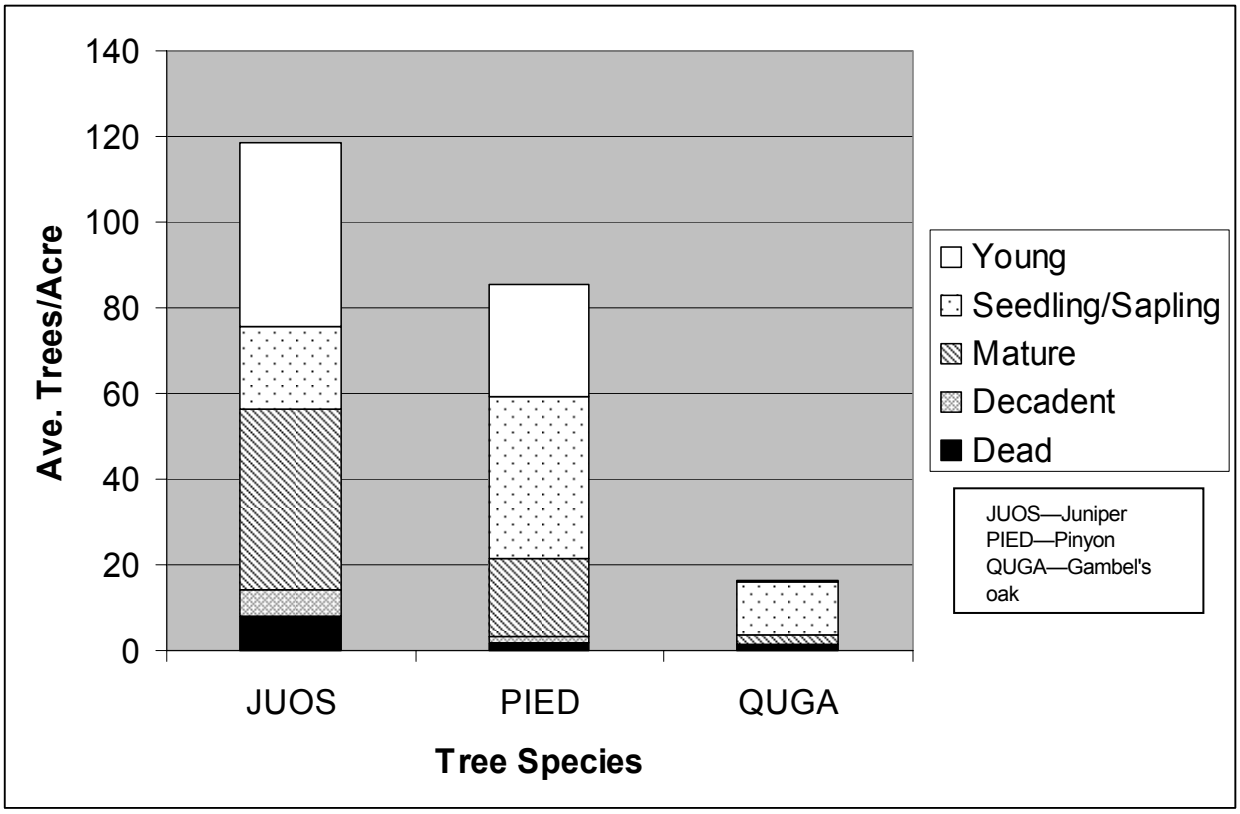


**Fig 2. General utilization of browse plants on the Buckskin Mountains.**

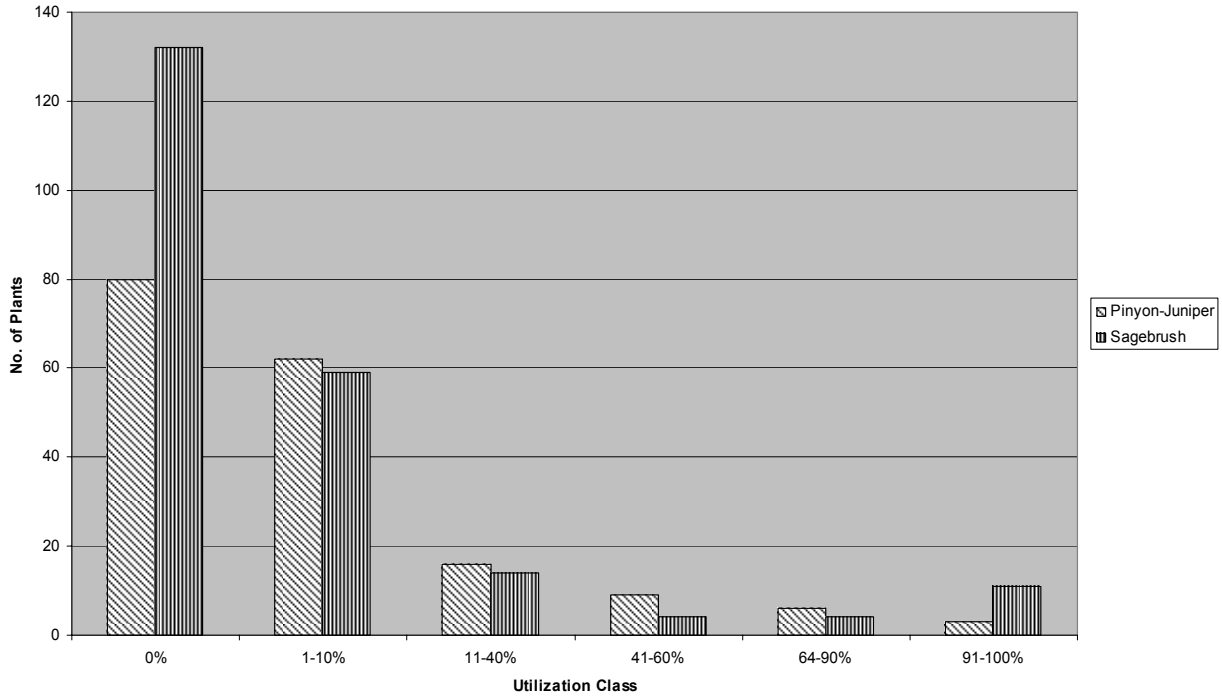



**Fig. 3. Utilization of browse plants by species for pinyon-juniper sites on the Buckskin Mountains**

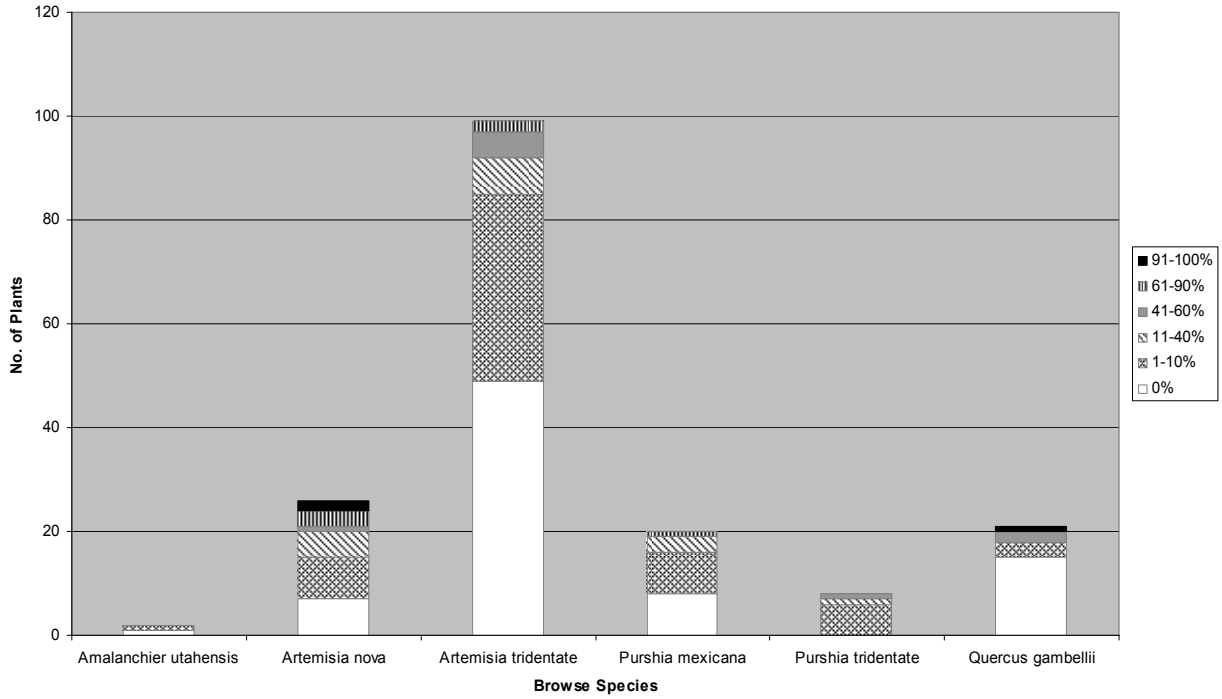


**Fig 4. Utilization of browse plants by species for sagebrush sites on the Buckskin Mountains**

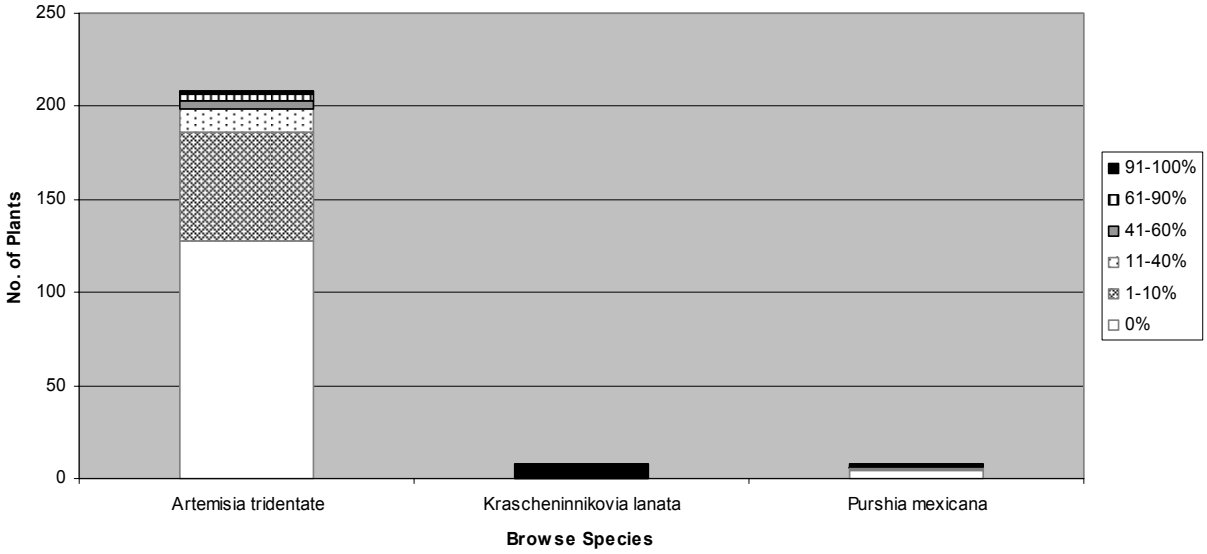
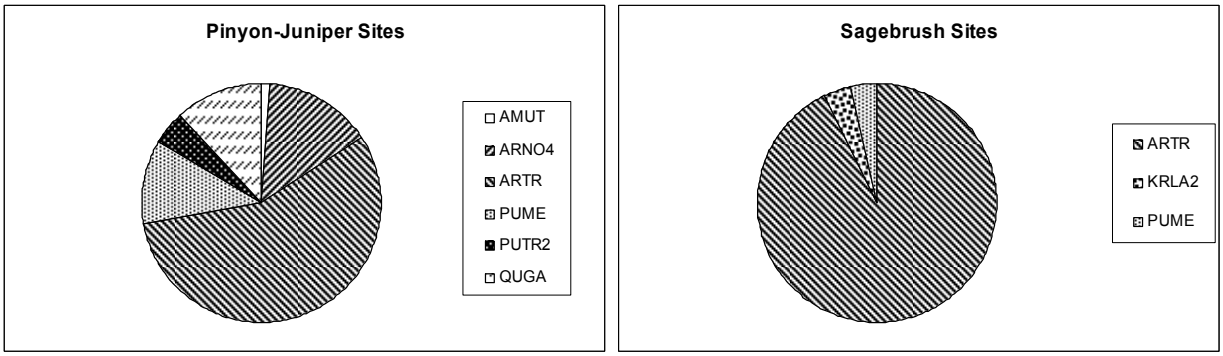



**Fig 5. Percentage of Browse Plants for the Buckskin Mountains**



# CHAPTER 12

*MAPS*

A. Map 1. Buckskin Mountain Assessment: Overview

Insert Map Here (Buckskin_map1_11x17_l.pdf)

B. Map 2. Buckskin Mountain Assessment: Fuelwood

Insert Map Here (Buckskin_map2_11x17_l.pdf)

C. Map 3. Buckskin Mountain Assessment: Allotments

Insert Map Here (Buckskin_map3_11x17_l.pdf)

D. Map 4. Buckskin Mountain Assessment: Soils

Insert Map Here (Buckskin_map4_11x17_l.pdf)

E. Map 5. Buckskin Mountain Assessment: GAP Data

Insert Map Here (Buckskin_map5_11x17_l.pdf)

F. Map 6. Buckskin Mountain Assessment: Sampling

Insert Map Here (Buckskin_map6_11x17_l.pdf)

G. Map 7. Buckskin Mountain Assessment: Fire Management Zone

Insert Map Here (Buckskin_map7_11x17_l.pdf)

H. Map 8. Buckskin Mountain Assessment: Visual Resource Classification

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